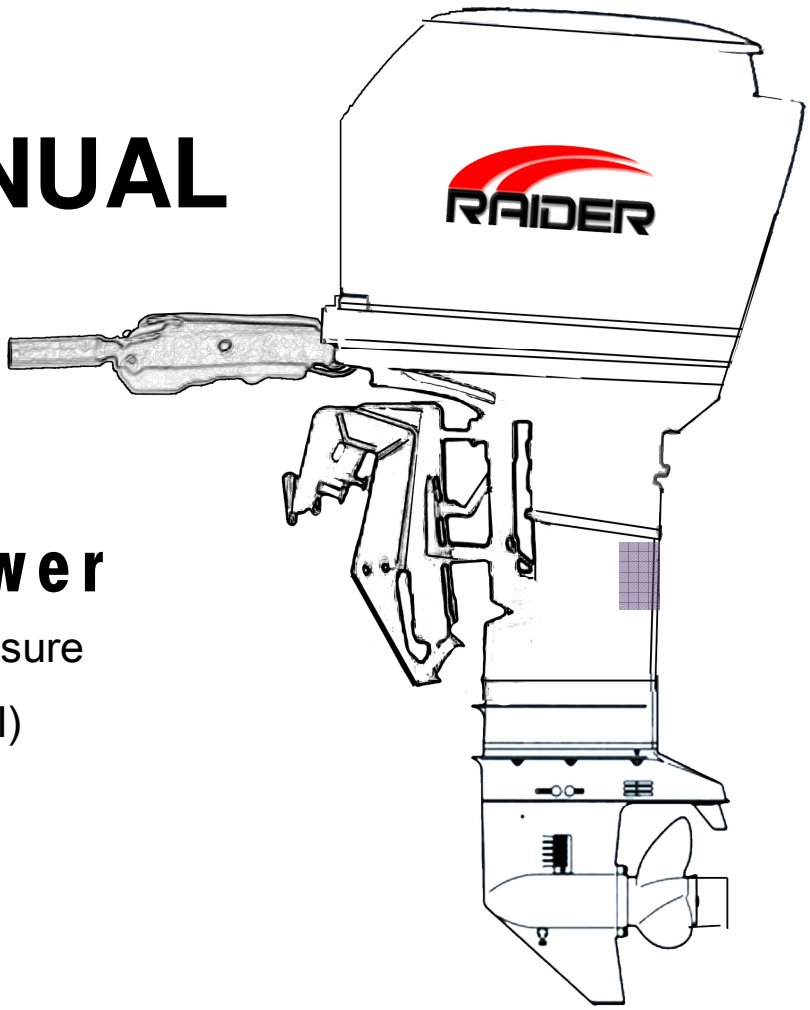
RAIDER

OUTBOARD

SERVICE MANUAL



50/40Horsepower

- Two stroke Low pressure
- Direct Injection (TLDI)
- Multi-fuel
- Submersible

This manual has been prepared for the United States Guardian Angels for service of the Multi-fuel, Submersible Outboard motor designed and manufactured under Contract No. N61331·11·C-0008, dated 3/4/11. The data presented in this manual was revised as of August 2013 representing the latest revision.

August 2013

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The 50 hp and 40 hp RAIDER outboards was designed and built for the U.S. military developed from a Mercury/Nissan/Tohatsu production product. Parts can be found worldwide common with these three motors.This manual represents the production version of the Raider outboard motors. Both outboards are capable of burning multiple fuels; that include JP5/8; kerosene, diesel, and gasoline. The Raider Outboards are design, built for total submersion for extended periods, and come equipped with dewatering valves. The outboards are designed for missions from submerged submarine or airdrop and specifically designed for the Rubber Inflatable Boat (RIB). The RAIDER outboard is available with a battery located under the cowling for quick starting in extremely cold conditions or for quick response to a mission after submersion. This battery option is a special order item. The basic Raider does not contain a battery. A pull start is the primary starting device with a rope backup for emergencies.

! General Safety Warnings

When replacement parts are required, use genuine RaCE or Mercury, Nissan, Tohatsu parts with equivalent characteristics including type, strength, and material. Failure to do so may result in product malfunction and possible injury to the operator and/or passengers.

To prevent possible eye injury, always wear SAFETY GLASSES while servicing the unit.

Always read and follow safety related precautions found on containers of hazardous substances like parts cleaners, primers, sealants, and sealant remover.

The engine cover is a machinery guard. Use caution when conducting tests on running engines. Do not wear jewelry or loose clothing. Keep hair, hands, and clothing away from rotating flywheel.

Replace any locking fastener (locknut or patch screw) if it's locking feature becomes weak. Definite resistance to tightening must be felt or locking fastener is not suitable for continued use. Replace only with authorized replacement part or equivalent.

When using shop air for cleaning or drying parts:

- **Be sure air supply is regulated to not more than 25 PSI (172 kPa).**

CONTENTS

Chapter 1 Specifications

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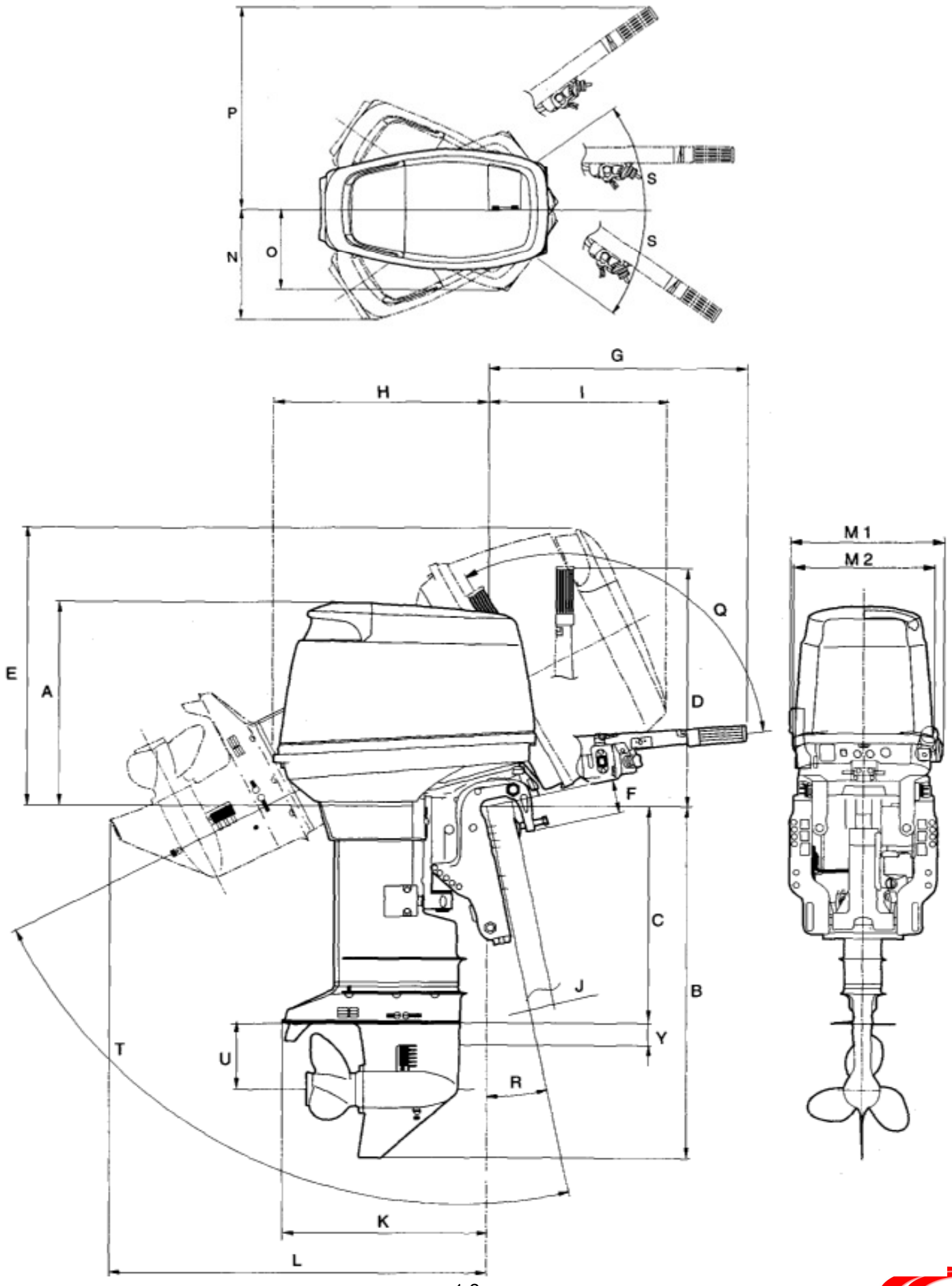
1. Specifications Table

ITEM	RAIDER 50 HP TLDI
Overall length	1120 mm (44.1 in.)
Overall width	384 mm (15.1 in.)
Overall height	1514 mm (59.6 in.)
Weight	92.0 kg (203 lbs.) – w/o composites/w/o starter & battery
Transom length	530 mm (20.9 in.)
Engine type	2-Stroke Direct Injection
Piston Displacement	697 ml (42.5 cu. In.)
Bore and Stroke	68 mm (2.68 in.) x 64 mm (2.52 in.)
Number of cylinders	3
W.O.T.	5150 – 5850 rpm
Trolling	700/800/900 rpm – 3 stages available
Idling	700/800/900 rpm - 3 stages available
Full throttle fuel consumption (approximately)	17 L/Hr (4.5 US gal/Hr) varies per fuel selection
Starting System	Pull Start; rope backup; under cowling battery optional
Intake System	Reed Valve
Scavenging system	5-port loop Charge
Exhaust system	Through hub
Lubrication system	Oil injection
Cooling system	Water-cooling
Water temperature control	Thermostat (with pressure relief valve)
Ignition System	Inductive
Ignition timing control	Electronics Control Unit (ECU)
Firing Order	1-2-3
Spark Plug	NGK: PZFR6H
Alternator	12V 280W (Maximum)
Battery	Not required; option available – under cowling
Trim Angle	4-24 degrees
Trim Angle settings	6 degrees
Maximum tilt-up angle	75 degrees
Transom board thickness	31-70 mm (1.22 – 2.76 in.)
Maximum steering angle	80 degrees
Gear shift	Dog clutch (F-N-R)
Gear ratio	1:85 (13 : 24)
Throttle Control	Tiller Handle
Fuel Tank	Bladder or tank Furnished by customer – normal fitting
Oil Tank	2L (2.1US qt.)
Fuel	JP5/8/diesel/kerosene/gasoline
Engine Oil	Genuine MD Gold or Equivalent
Gear Oil	API GL5, SAE#80 to #90 500 ml (16.89 fl. Oz.)
Submersibility	66 ft/18 hours-Tested
Handling/grab rails	Yes. Fits through submarine hatch

2. Outline Dimensions



External Dimensions

Item	50A	Remarks
A	495 mm (19.5 in)	
B	Transom (5) 728 mm (28.7 in)	
	Transom (L) 855 mm (33.7 in)	
	Transom (UL) 982 mm (38.7 in)	
C	Transom (S) 403 mm (15.9 in)	
	Transom (L) 530 mm (20.9 in)	
	Transom (UL) 657 mm (25.9 in)	
D	568 mm (22.4 in)	
E	680 mm (26.8 in)	
F	85 mm (3.3 in)	
G	600 mm (23.6 in)	
H	520 mm (20.5 in)	
I	440 mm (17.3 in)	
J	31-70mm (1.2-2.8 in)	
K	490 mm (19.3 in)	
L	Transom (5) 800 mm (31.5 in)	
	Transom (L) 910 mm (35.8 in)	
	Transom (UL) 1025 mm (40.4 in)	
Ml	384 mm (15.1 in)	
M2	345 mm (13.6 in)	
N	310mm (12.2 in)	
0	235 mm (9.3 in)	
P	565 mm (22.2 in)	
Q	l2odeg.	
R	l2deg.	
S	35deg.	
T	75deg.	
U	161 mm (6.3 in)	
Y	54mm (2.1 in)	

3. What is TLDI?

The abbreviation TLDI stands for Two-stroke Low-pressure Direct Injection and is the name applied to direct fuel-injection system engines.

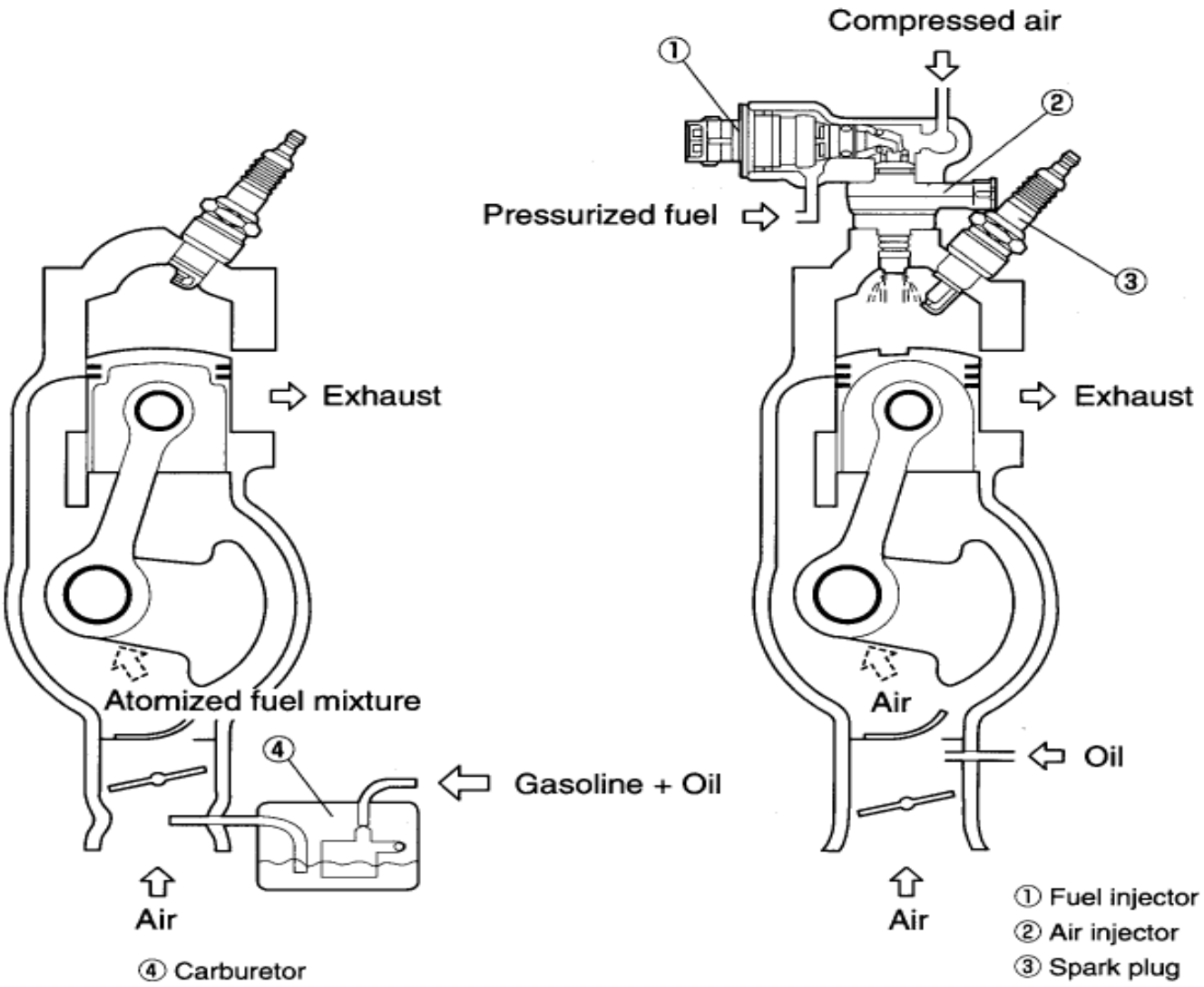
a) **Two-Stroke Low-Pressure Direct Injection (TLDI)**

TLDI is the name RAIDER uses for two-stroke engines that utilize the air-assisted, low-pressure direct injection system.

The air-assisted, low-pressure direct injection system has been combined with the Inductive ignition system and Engine Control Unit (ECU), which performs precision control of fuel mixture, injection timing and ignition timing to maximize combustion efficiency in the TLDI engine. The result is better fuel economy, and low emission maintaining superior advantage of powerful two-stroke engine.

b) **Air-Assisted Low-Pressure Direct Injection**

The air-assisted, low-pressure direct fuel injection process involves using an air compressor to pressurize the fuel supplied by the fuel pump to inject it directly into combustion chambers in the form of a finely atomized mixture to achieve maximum combustion efficiency.



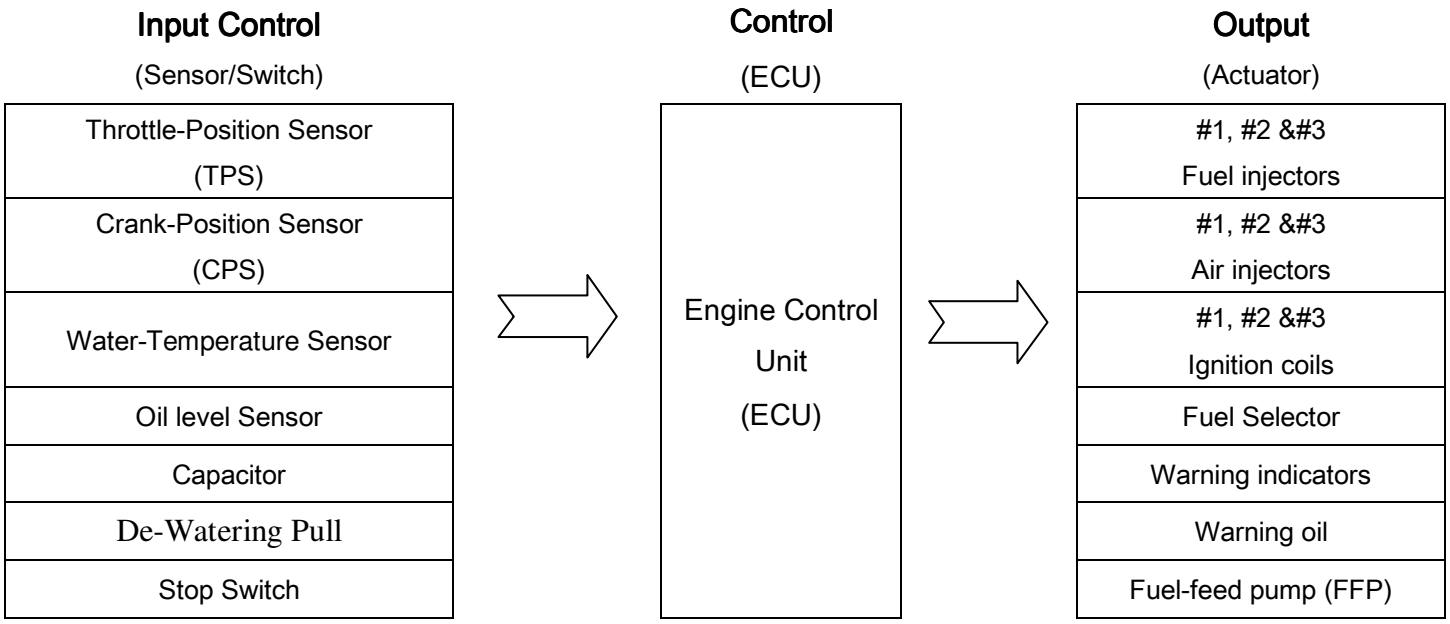
Engine with

CARBURETOR TLDI

c) **ECU Control**

With TLDI, a network of connected sensors enables the Engine Control Unit (ECU) to precisely regulate fuel mixture, injection rate and ignition timing. The ECU also uses a stratified fuel feed process to provide lean combustion in the low-speed range, while utilizing more homogenized change to ensure the fuel mixture is distributed uniformly throughout the combustion chamber when operating in the high-speed range to ensure maximum combustion efficiency.

Below is a block diagram of the Engine Control Unit that allows the Raider 50 horsepower outboard to function as a multi-fuel engine.



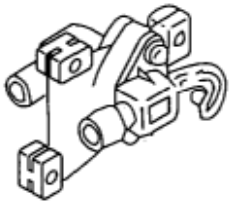
Note: All warning indicators have been silenced on the Raider to not compromise missions.

RAIDER has also integrated a series of mechanical valves into the TLDI to remove water from the system after submersion. These valves are detailed in detail in Chapter 7.

Inductive Ignition System (Requires No Battery)

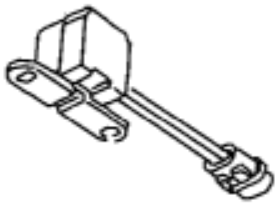
TLDI is nowusing the inductive ignition system to maximize combustion efficiency and fuel economy, and to minimize exhaust emissions. The ECU inductive ignition system has been modified to support both a higher and longer spark via the spark plug than conventional TLDI commercial models using L-CDI (Long Arc Duration CDI). This feature was added to insure a quicker start after submersion than any conventional CDI systems. The improved Inductive Ignition System in the Raider TLDI engine provides a smoother running outboard than any commercial outboard.

Throttle-Position Sensor (TPS)



Throttle-position sensor system is comprised of TPS1 and TPS2. The twoTPS's are used in combination to detect throttle butterfly valve position and advancer arm position and relays the information to the ECU.

Crank-Position Sensor (CPS)



Crank-position sensor is designed to sense the encoder located above the ring gear on the flywheel in order to detect crankshaft position and transmit's the information to the ECU.

Water-Temperature Sensor

Positioned on the water jacket installed on the cylinder, water-temperature sensor is used to detect temperature of cooling water in the cylinder and relay's the information to ECU.

Oil Level Sensor

Oil level sensor is used to detect the level of remaining oil in oil tank and relay's the information to the ECU.

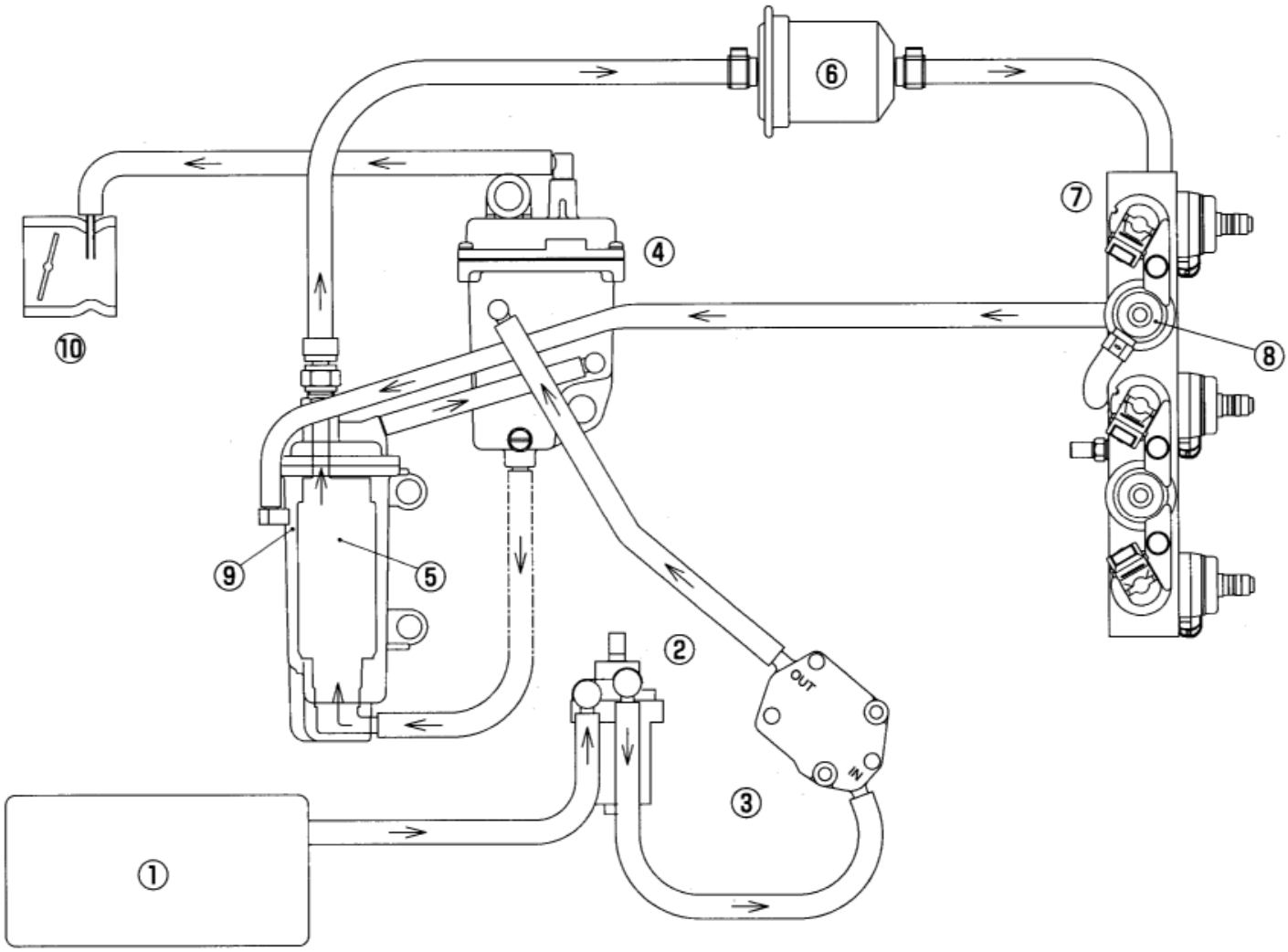
Air Injectors

Air injectors are used to inject a fine mist of fuel and compressed air into each combustion chamber. The ECU determines the mixture and timing for injecting fuel according to current engine operating conditions based on information relayed from the various sensors.

Fuel Injector

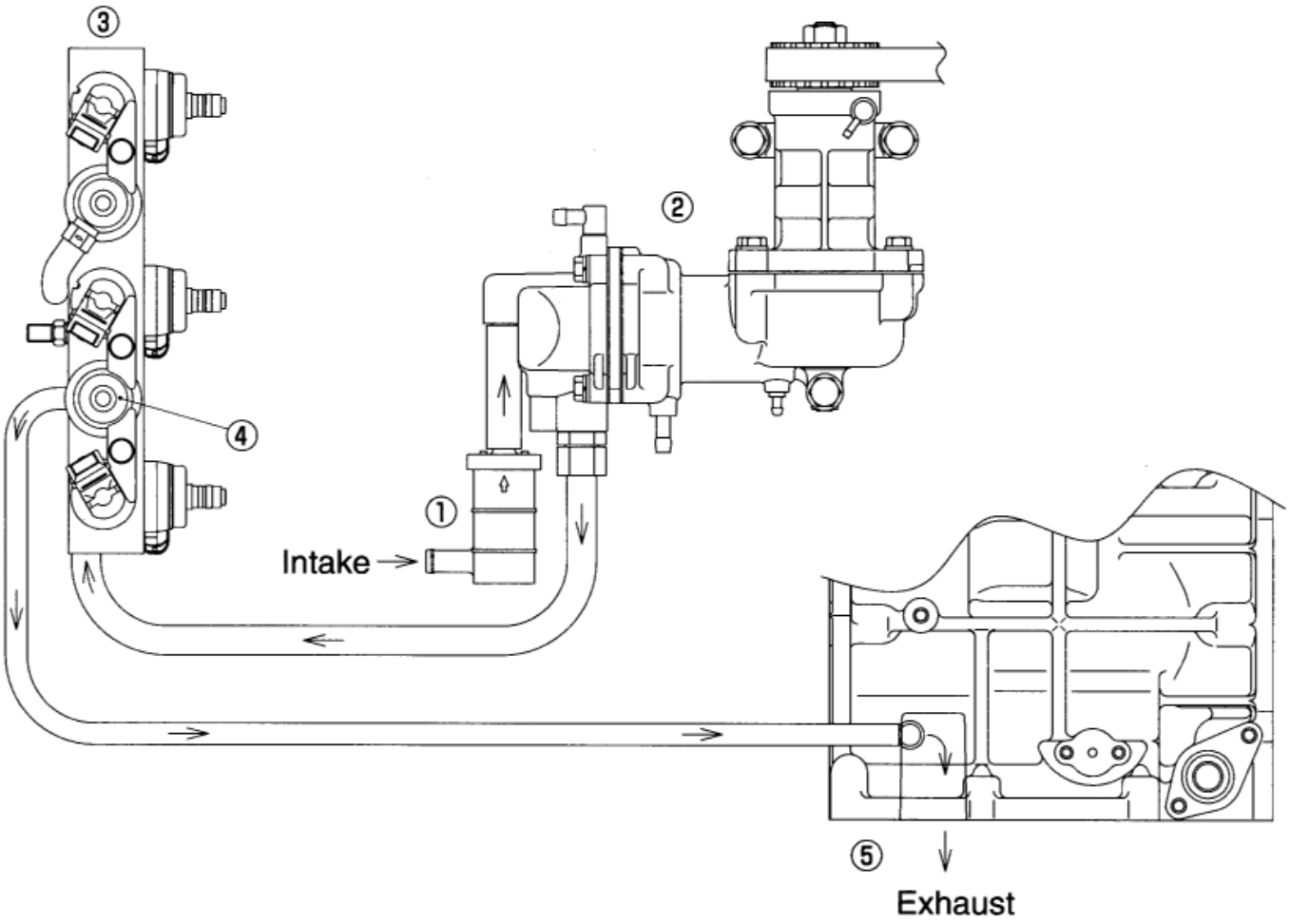
Fuel injectors supply the fuel in the air rail to the air injectors via the set pieces. The ECU determines the mixture for injecting fuel according to current engine operation based on information relayed from the various sensors.

4.Fuel Supply System



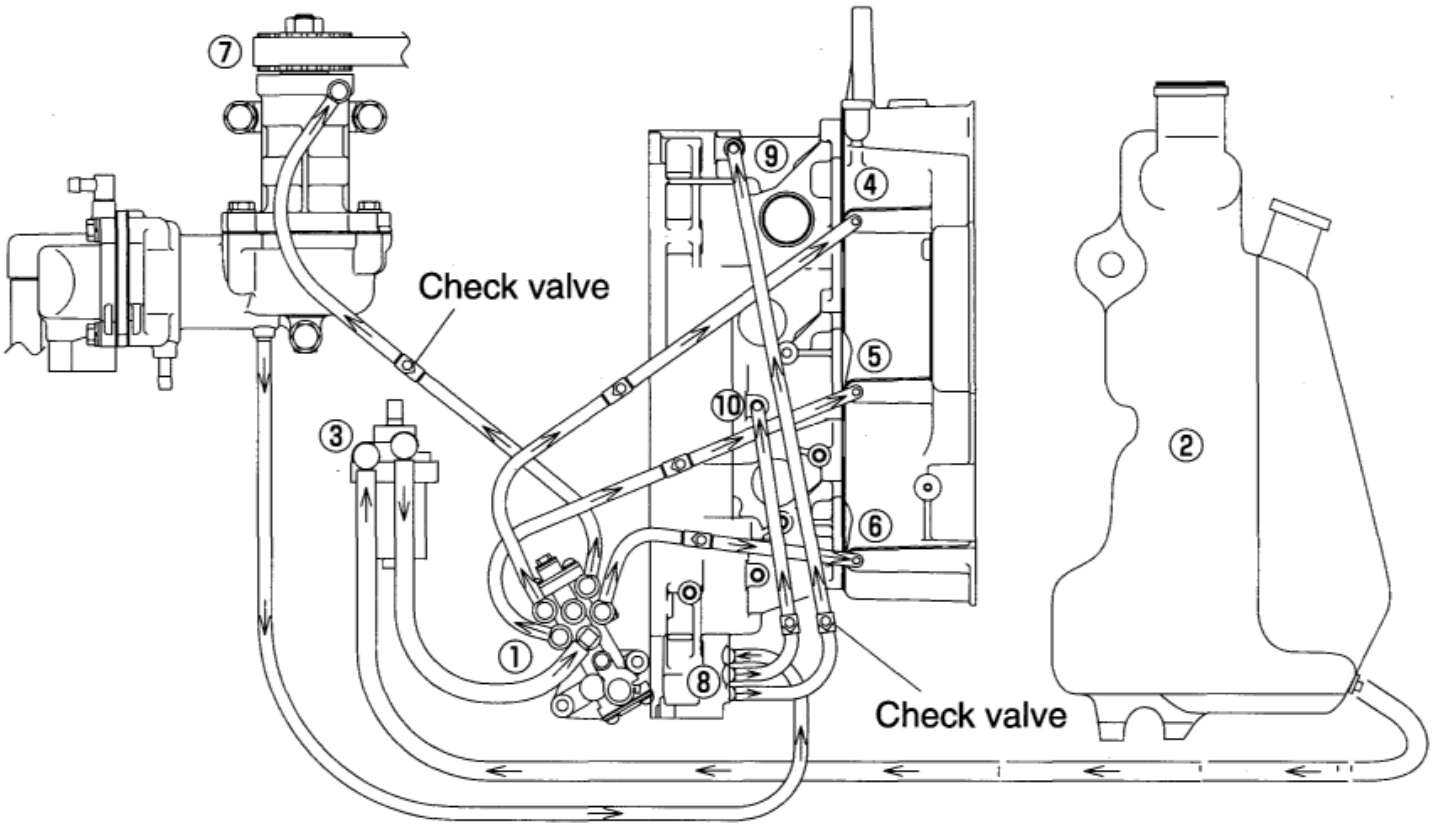
Starting the engine activates the fuel pump (3), which draws fuel from the fuel tank (1) and routes it through the fuel filter (2) to the vapor separator (4). The fuel is pressurized in the fuel-feed pump (FFP) (5); then passes through the high-pressure filter (6) to the air rail (7), from there it is injected into the combustion chambers. The fuel regulator (8) regulates fuel pressure so as to keep it 70 kPa (10 psi)higher than the pressurized air pressure (55OkPa Bopsi)to inject fuel into combustion chamber after overcoming the air pressure mentioned in “Air supply system” as follows. Any excess fuelis depressurized and diverted through the FFP case (9) and back to the vapor separator (4). The returned fuel contains air bubbles left over from being pressurized at (5). These bleed from the top of the vapor separator (4) to the throttle body (10) and is fed to the air intake system.

5.Air Supply System



Starting the engine operates the air compressor (2), draws air in through the air filter (1) and sends compressed air through to the air rail (3). The air regulator (4) regulates air at the optimum combustion pressure of 550 kPa (80 psi) and the regulated air is injected into engine combustion chamber together with pressurized fuel. Any excess air is depressurized and discharged into exhaust gas (5) from the bottom of the cylinder.

6. Oil Supply System



Starting the engine operates the oil pump (1), which draws oil from the oil tank (2) and routes it through the oil filter (3) to the oil pump (1). The oil pump channels the oil through four ports to #1 air box (4) air box #2 air box (5), #3 air box (6) and the air compressor (7). Ports (4), (5) and(6) serve to lubricate the engine pistons, while port (7) lubricates the air compressor.

TLDI includes an oil recirculation system in which the excess oil from the air compressor (7)is diverted to #3 crankcase (8) for use in lubricating the drive gear of oil pump (1). Any oil left over from there is diverted to crank upper bearing and #1 crankcase (8), and the crankcase (10) where it is added to oil from (4) and (5) andreused to lubricate the engine.

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Chapter 2 -Servicing Information


RAIDER


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1. General Precautions for Servicing

Users of this manual should observe the following general precautions when conducting disassembly and assembly work.

(1) Make sure that the outboard motor is securely mounted on a work stand before starting work.

(2) Take care not to scratch or damage painted surfaces and the mating surfaces where cylinders, the cylinder head, the crankcase and other parts are joined.

(3) Always replace packing, gaskets, 0-rings and split pins with new ones when reassembling engine parts. Make a point of replacing snap rings as well.

(4) When replacing, be sure to use genuine Raider brand parts and lubricants or products recommended by RAIDER.

(5) Always use the recommended special tools to ensure work is done properly.

(6) When disassembling and assembling components, make note of position marks, adding your own marks if none are provided, as a way to ensure the various parts and components are properly mated when being reassembled.

(7) To prevent smaller parts, such as bolts, nuts and washers from getting lost or damaged, where possible, lightly insert or tighten them back in their original locations.

(8) As normal practice, check disassembled parts for any wear or damage by first wiping them clean; then washing them in solvent.

(9) With reassembly operations it is essential to observe precise detail in centering, vacuum sealing, lubricating (with oil or grease), packing parts and components, and connecting wiring and piping. Also ensure there are no blockages in fluid lines.

1) When reassembling parts requiring numerous nuts and bolts (cylinder, crankcase etc.), begin by alternately tightening diagonally opposed inner bolts, moving in a concentric circle; then tightening the outer bolts. This will ensure that engine parts are assembled evenly and securely. (Use the same procedure in the reverseorder when disassembling.)

2) When installing oil seals, be careful not to scratch or reverse the sides that mate with the shaft and always apply grease to the lip surfaces.

3) Confirm the correct quantity and thickness when applying sealant. Applying excessively will result in the excess portion being excreted into or outside of the case, potentially causing damage. Adhere strictly to the written instructions when applying adhesives.

4) Apply penetrating oil spray to nuts or bolts that are difficult to remove due to rust and wait 5 minutes before removing.

5) For the various inspection specifications, torque values, special tools, and the points where sealant, adhesive and grease are to be applied, refer to the relevant tables.

6) The various nuts, bolts and washers referred to in this manual are various nuts, bolts and washers referred to in this manual are listed below.

Name	Type	Diameter	Length
H820	Hexagon bolt	8mm	20 mm
N8	Hexagonnut (	8mm	
L8	Hexagon nut	8mm	
W8	Plain washer	8mm	
SW8	Spring washer	8mm	
Screw 620	Pan head screw	6mm	20mm

(10)Observe all necessary safety procedures to prevent accidents and injury during work operations.

2.Specifications and Standards Used in Servicing

Name of Part	Item to check	Standard values
Piston	• Outer diameter Measure at a point 12 mm (0.47 in) above the lower edge of the piston skirt.	• 67.96 mm (2.676 in)
Piston ring	• Ring end gap Note: If a ring gauge is unavailable, measure the lower end of the cylinder bore.	• Top: 0.22 to 0.37 mm (0.009 to 0.01 45 in) • Second & third:0.33 to 0.48 mm (0.013 to 0.019 in)
Crankshaft	• Deflection Measure with both ends supported on V blocks.	• 0.05 mm (0.002 in)
Connecting rod	• Deflection	
Cylinder head	• Mating surface	• 0.03 mm (0.0012 in) or less for scratches • 0.03 mm (0.0012 in) or less for distortion
Cylinder	• Mating surface • Cylinder liner scratches and wear	• 0.03 mm (0.0012 in) or less for scratches • 0.03mm (0.0012 in) or less for distortion
Engine block	• Compression Measure after warning: Remove all 3 spark plugs. Remove air injector and fuel injector connectors.	• 830 KPa (8.5 kg/cm^2, 120 psi)
Reed valve stopper	• Lift height	• 9.3 to 9.5 mm (0.366 to 0.374 in)
Reed valve	• Fails to close, isworn or damaged	
Ignition coil	• Primary coil resistance (between black L-B/R,B/W,B/G lines) • Secondary coil resistance (between spark plug cap terminal and B line)	• 0.5 ohm ±10% (20'C, 68~F) • 13.5 k ohm ±20% (20°C, 68°F.)
ECU	• Low-speed ESG trigger • High-speed ESG trigger	• Approx. 3,000 rpm • Approx. 6,000 rpm

Service limit	Servicing procedure
• 0.8 mm (0.031 in) or more • 0.9 mm (0.035 in) or more	• Replace with new piston ring if cylinder liner wear has not yet exceeded the repair limit.
• 0.05 mm (0.002 in) or more	• Replace with new crankshaft.
• 2 mm (0.08 in) or more	• Replace with new crankshaft assembly.
• Scratch depth or distortion is 0.03 mm (0.0012 in) or more	• Repair by polishing the surface plate, starting with #240 to #400 grit sandpaper and finishing with #600 grit sandpaper.
• Scratch depth or distortion is 0.03 mm (0.0012 in) or more • When the cylinder liner cannot be repaired using #400 to #600 sandpaper due to excessive scratching or scoring or when the difference between the maximum and minimum points of wear in liner bore is 0.06 mm (0.0024 in) or more	• Repair by polishing the surface plate, starting with #240 to #400 grit sandpaper and finishing with #600 grit sandpaper. • Bore and hone to 068.55 (2.699 in) + 0 to 0.02 mm (0 to 0.0008 in). Check ports and grind if necessary. Use oversize pistons and piston rings.
1) When difference in compression between cylinders exceeds lOOKPa (1.05 kg/cm^2, 14.5 psi) 2) When abnormally higher than standard value	1) Bore and hone to 068.55 (2.699 in) + 0 to 0.02 mm (0 to 0.0008 in). Check ports and grind if necessary. Use oversize pistons and piston rings. 2) Remove carbon from piston crown and cylinder head surfaces and clean exhaust gas bypass valve.
• No longer conforms to standard value	• Replace with new part.
• Valve reed fails to close • Excessive wear on valve seat • Valve is damaged	• Replace entire valve assembly.

Name of Part	Item to check	Standard values
Magneto	• Sparking performance Measured using spark tester • Sparking order • Alternator (max.) • Charging performance • Alternator coil resistance value (Y to Y wire)	• 10 mm (0.39 in) or more at 350 rpm • #1 → #2 →#3 • 280 W • 1,500 rpm l2V 16.5A • 5,500 rpm 12V 18.5A • 0.44 Ω ohms ±15% (20°C, 68°F)
Spark plug	• • Standard plug • Plug gap	• . NGK: PZFR6H • 0.7 ~ 0.8 mm (0.0276 0.0315 in)
Crank position sensor (CPS)	• Gap with encoder ring (flywheel) • Pickup coil resistance value (L wire to G wire)	• 0.5 to 0.9 mm (0.019 to 0.035 in) • 5311_ ± 15~ (20°C, 68°F)
Thermostat	• Opening and closing of thermostat valve	• Valve start temperature: 52°C (125.6°F) • Valve full-open temperature: 65°C(149.0°F) • Valve full-open lift: 3mm (0.12 in) or more
Fuse	• Capacity	• 15A x 1, 25Ax1, 30A xl
Pump impeller Pump case liner Guide plate	• Wear and cracks	
Propeller shaft	• Damage to bearing • Wear on lip of oil seal	
Drive shaft	• Damage to bearing • Shaft run-out • Wear on lip of oil seal	• 0.3 mm (0.012 in) or less (Using both center holes for reference)
De-Watering	• Damage to pull knob • Rod gets damaged • Valves stick	
Anode	• Corrosion	
Oil seals	• Wear • Damage	

Service limit	Servicing procedure
1) 1.0 mm (0.047 in) or more 2) When electrodes show excessive wear	1) Repair so that plugs conform to standard values. 2) Replace with new spark plug.
• When sensor no longer conforms to standard value	• Repair so that sensor conforms to standard value.
• When fuse burns out	• Replace with new fuse.
• When the tips, and upper and lower surface lip areas show wear, cracks or damage • When depth of wear is 0.1 mm (0.004 in) or more	• Replace with new assembly. • Replace with new shaft.
	• Replace with new shaft.
• 0.4 mm (0.016 in) or more • When depth of wear is 0.1 mm (0.004 in) or more	• Repair so that shaft conforms to standard values. • Replace with new shaft.
• When anode shows excessive corrosion	• Replace with new anode.
• When lip area shows deterioration, heat discoloration or damage or when wear reduces interference to 0.5 mm (0.02 in) or less	• Replace with new oil seal.

<table>
<tr><th>Name of Part</th><th>Item to check</th><th>Standard values</th></tr>
<tr><td>Manual Trim and Tilt</td><td>Tilt Cylinder</td><td>• 19600 to 24500 kPa</td></tr>
<tr><td>Air Compressor</td><td>• Cylinder bore
• Piston diameter
Measure at a point 10 mm above the lower edge of the piston skirt
• Piston ring and gap
• Reed valve tip clearance
• Drive belt</td><td>• 39.00 to 39.02 mm (1.53 to 1,54 in.)
• 38.97 to 38.99 mm (1.534 to 1.535 in.)
• Top: 0.10 to 0.25 mm (0.004 to 0.098 in.)
• Second: 0.10 to 0.25 mm (0.004 to 0.098 in)
• 0.2 mm (0.008 in) or less</td></tr>
<tr><td>Vapor Separator</td><td>• Wear and damage on seal ring
• Float</td><td></td></tr>
<tr><td>Fuel Feed Pump (FFP)</td><td>• Wear and damage on seals and grommets</td><td></td></tr>
<tr><td>Air rail</td><td>• Wear and damage on O-rings</td><td></td></tr>
<tr><td>Air regulator</td><td>• Air pressure</td><td>• 550kPa (5.6 kg/cm2) +/- 7% (80 psi +/- 7%)</td></tr>
<tr><td>Fuel regulator</td><td>• Fuel pressure</td><td>• Measured air pressure + 70 kPa (0.7 kg/cm2) +/- 10% (10 psi +/- 10%)</td></tr>
<tr><td>Air injector</td><td>• Measured value for resistance
• Operating condition (check for clicking sound when 12 volts is applied)</td><td>• 1.29 +/- 0.1 ohm (20 deg. C, 68 deg. F)</td></tr>
<tr><td>Fuel injector</td><td>• Measured value for resistance</td><td>• 1.8 +/- 0.1 ohm (20 deg. C, 68 deg. F)</td></tr>
<tr><td>Throttle position sensor (TPS)</td><td>• Measured values of resistance between connectors.</td><td>• Between upper and lower connectors: 5.0 ohms +/- 20%
• Between upper and middle connectors: resistance value (k ohms)<table><tr><td></td><td>Fully closed (</td><td>Full Open</td></tr><tr><td>TPS 1</td><td>0.5 to 1</td><td>4 to 5</td></tr></table></td></tr>
<tr><td>Water Temperature sensor</td><td>• Measured values of resistance</td><td>• 2.6k ohms +/- 10% (20 deg. C; 68 deg. F)
0.3 k ohms +/- 5% (80 deg. C; 176 deg. F)</td></tr>
<tr><td>Oil Level sensor</td><td>• Conductivity</td><td></td></tr>
<tr><td>Rectifiers</td><td>• Conductivity</td><td>• Refer to tester checkpoint Table (Chapter 5)</td></tr>
</table>

Service limit	Servicing procedure
• When parts no longer conform to standard values • When parts show excessive wear or damage	• Replace with new parts.
• When parts show excessive wear or damage • When parts showed deterioration or contamination by fuel	• Replace with new parts.
• When parts show excessive wear or damage	• Replace with new parts.
• When parts show excessive wear or damage	• Replace with new parts.
• When parts no longer conform to standard values	• Replace with new parts.
• When parts no longer conform to standard values	• Replace with new parts.
• When parts no longer conform to standard values	• Replace with new parts.
• When parts no longer conform to standard values	• Replace with new parts.
• When parts no longer conform to standard values • When differences u~ resistance values between upper, middle and lower connectors becomes erratic	• Replace with new parts.
• When parts no longer conform to standard values	• Replace with new parts.
• When short occurs in sensor	• Replace with new parts.
	• Replace with new parts.

3.Lists of Points for Applying Sealant, Adhesive and Lubrication

Application points		Three bond Thread Lock 1342	Three bond Thread Lock 1373B	Locitite Adhesive Adhesive 648 Primer 7471	Locitite Sealant 518	Three bond Instant Adhesive 1741	Three Bond Adhesive G17
Engine block	Piston						
	Piston pin						
	Piston ring						
	Cylinder liner						
	Drive pulley			O			
	Pulley nut	O					
	Small-end bearing						
	Big-end bearing						
	Main bearing	O					
	Big-end bearing washer						
	Main bearing, upper						
	Main bearing, upper oil seal						
	Crankcase head O-ring						
	Crankshaft oil seal, lower ,						
	Drive shaft oil seal						
	Oil pump for drive gear						
	Oil pump for driven gear						
	Cylinder-crankcase mating surface				O		
	Water temperature sensor						
	Spark plug cap						
	Reed valve assembly bolt	O					
	Advancer arm						
	Throttle cam						
	Throttle cam bolt	O					
	Clutch arm						
	Ball joint gap						
	Cable joint (clutch)						
Steering bar handle specifications	Grip						
	Bushing A						
	Bushing B						
	Washer						
	Wave washer						
	Throttle shaft bushing						
	Shift lever shaft bushing						
	Seal ring						
	Wave washer						

	Shift lever stopper						

Cold & Heat resistant Lithium grease LT-2	Oil Center Research cold-resistant grease LOR#101	OBM grease	2st engine oil	Silicon grease, Shinetsu grease KS-64	Specified gear oil	Power trim & tilt fluid #1	Remarks
			O				Ring groove, piston pin hole and skirt
			O				Skirt
			O				Inwall
							Apply Loctite 648 to the punched side after applying primer to the shaft and punched surface
			O				Sliding surface
			O				Sliding surface
			O				Sliding surface
			O				Sliding surface
	O						Lip area
	O						Lip area (on oil seal in crankcase head)
	O						Lip area (on oil seal in crankcase head)
							Confirm thickness of coating
		O					0-ring
							Plug seat and high tension cored
O							Sliding surface
O							Sliding surface
O							Sliding surface
O							Sliding surface
O							Sliding surface
	O						Sliding surface
		bO		aO			a) Terminal, b) Pinion
				O			Terminal
				O			Terminal
		O					
		O					
		O					
		O					
		O					
		O					
		O					
		O					

		O					

Application points		Three bond Thread Lock 1342	Three bond Thread Lock 1107	Three bond Thread Lock 1373B	Locitite Adhesive Adhesive 64B Primer 7471	Locitite Sealant 518	Three bond Instant Adhesive 1741	Three Bond Adhesive G17
Air rail	Air injector 0-ring							
	Fuel injector 0-ring							
	Fuel regulator 0-ring							
	Air regulator 0-ring							
	Compressions seal							
	Spark plug 0-ring							
	Air hose L nipple 0-ring							
	Fuel hose L nipple 0-ring							
	Valve assembly	O						
Air compressor	Air compressor piston							
	Air compressor cylinder							
	Air compressor piston pin							
	Air compressor piston ring							
	Air compressor oil ring							
	Big-end needle bearing							
	Compressor housing oil seal							
	Compressor crankshaft BIG							
	Adapter hose joint	O						
FFP assembly	Adapter hose joint	O						
	Cable Terminal grommet							
	FFP upper grommet							
	FFP lower grommet							
	Pipe grommet	O						
Gear case & Driveshaft housing	Gear B nut	O						
	Propeller shaft housing							
	Propeller shaft housing 0-ring							
	Propeller shaft oil seal							
	Propeller shaft							
	Propeller stopper							
	Propeller thrust holder							
	Water pump case, lower							
	Water pump case (lower) 0-ring							
	Water pump case (lower) oil se~							
	Pump case bolt							
	Water pipe							
	Water pipe seal rubber, upper							
	Water pipe seal rubber, lower							O
	Water pipe seal lock rubber							
	Pump case							
	Engine base gasket		O					
	Engine base seal rubber						O	
	Exhaust housing grommet						O	O
	Idling port grommet						O	O
	Trim tab retainer bolt							
	Drive shaft							

Cold & Heat Resistant Lithium grease LT-2	Oil Center Research cold-resistant grease LOR#101	OBM grease	2st engine oil	Silicon grease, Shinetsu grease KS-64	Specified gear oil	Power trim & tilt fluid #1	Remarks
			O				O-rings at 2 locations
			O				O-rings at 2 locations
			O				O-rings at 2 locations
			O				O-rings at 2 locations
			O				Air rail, 6 locations
			O				Air rail, 3 locations
			O				O-rings at 2 locations
			O				O-rings at 2 locations
			O				Taper screw
			O				Entire outer surface
			O				Entire outer surface
			O				Apply when inserting pin
			O				Entire outer surface
			O				Entire outer surface
			O				Rollers
	O						Inner and outer area of lip
			O				Rollers
			O				Embedded section (M1OPI.0)
			O				Embedded section (M1OPI.0)
			O				Both inner and outer surfaces
			O				Both inner and outer surfaces
			O				Both inner and outer surfaces
			O				Both inner and outer surfaces
							Apply after cleaning all grease from threading
		O					Lower inner surface
		O					
		O					Lip surface
		O					Spline surface
		O					Tapered surface
		O					Spline Surface
		O					Lower inner part
		O					
		O					Lip surface
		O					Under-neck surface
		O					Upper surface
		O					Exterior
					O		a) Pump case, b) Interior
		O					Entire surface
		O					Lightly on inner surface
O							
							Apply to one of the mating surfaces
							Apply to one of the mating surfaces
		O					
O							Apply to engine side spline

Application points		Three bond Thread Lock 1342	Three bond Thread Lock 1373B	Locitite Adhesive Adhesive 648 Primer 7471	Locitite Sealant 518	Three bond Instant Adhesive 1741	Three Bond Adhesive G17
Gear case	Cam rod bushing						
	Cam rod bushing O-ring, 2.4 to 5.9						
	Cam rod bushing O-ring, 3.5 to 21.7						
	Cam rod bushing stopper bolt						
	Gear case lubricating oil						
	Gear case bolt						
	Extension housing bolt						
	Propeller shaft housing bolt	O (*2)					
Stern bracket section	Bracket bolt						
	Bracket bolt cap						
	Stem bracket washer						
	Swivel bracket	O					
	Steering shaft						
	Steering shaft bushing						
	Steering shaft seal ring						
	Thrust plate						
	Mounting bolt, upper	O					
	Mounting bracket						
	Tilt stopper						
Motor cover, upper	Filler lid hinge						
	Hook lever						
	Hook lever bushing	O					
	Hook lever seal ring						
	Filler lid seal rubber						O
PTT Section	PTT cylinder pin, upper	O					
	PTT cylinder pin, lower						
	PTT sensor cam bolt						
	PTT tilt stopper knob						O
	PTT oil						
	Joint Metal	O					
	O-ring						
	Yoke O-ring						
	Tank cap O-ring						
	pump O-ring						
	Relief valve O-ring						
	Reserve tank O-ring						
	Reserve tank seal						
Remote control	Drag link						
	Control box						
Nipples		O					

*2 When reinstalling the used bolt the adhesive specified must be applied

Cold & Heat resistant Lithium LT-2	Oil Center Research cold-resistant LOR#101	OBM grease	2st engine oil	Silicon grease, Shinetsu KS-64	Specified gear oil	Power trim & tilt fluid #1	Remarks
		O					Entire surface
					O		
		O					
		O					Under-neck surface
					O		Oil capacity 500 ml
		O					Under-neck surface
		O					Under-neck surface
		O					Under-neck surface
		O					Fill with grease, apply grease to tapped hole
		O					Inner surface
		O					Both surfaces
		O					Fill interior with grease
		O					Sliding surface
		O					Sliding surface
			O				
			O				Sliding surface
							Thread
		O					Spline surface
		O					Sliding surface
		O					Sliding surface
		O					Sliding surface
		O					Sliding surface
		O					Sliding surface
		O					Sliding surface
							Use the specified lubricant
						O	
						O	
						O	
						O	
						O	
						O	
						O	
						O	
						O	Sliding surface
						O	Each press-in port

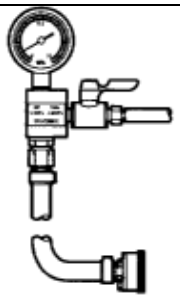
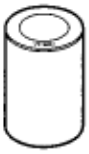
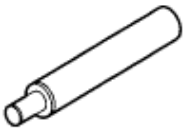
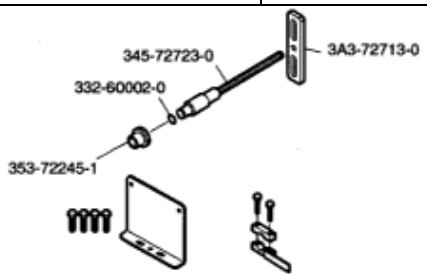
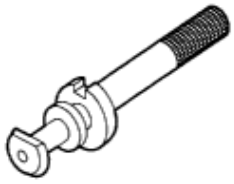
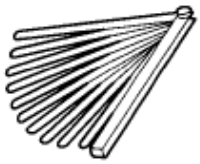
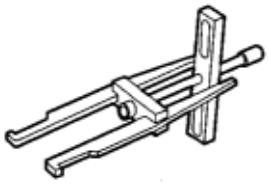
4. Torque Table

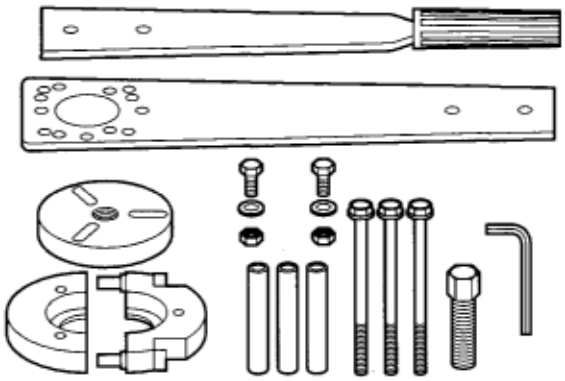
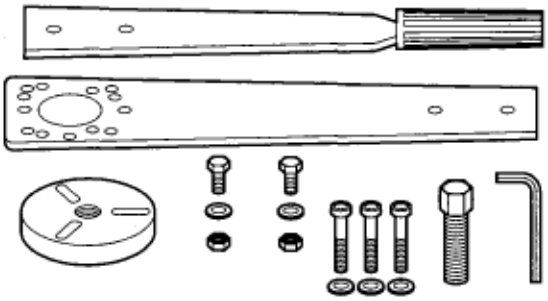
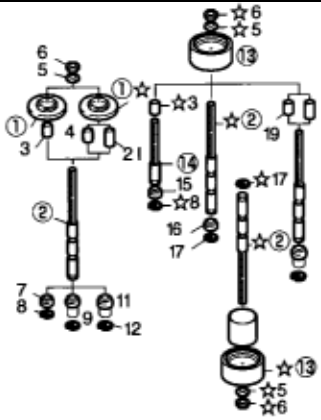
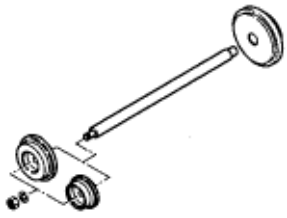
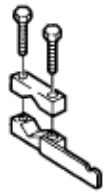
	Item	Part to tighten	Initial torque (N-m)	Full torque (N-m)	lb-ft
Engine	Cylinder head cover -	Bolt (M6)	①2.0 - 2.9	④4.6 - 6.3 (0.5-0.6 kg-m)	3.6 - 4.4
	Cylinder head cover	Bolt (M8)	②12 - 15	③29-34 (3.0 - 3.5 kg-m)	22 - 25
	Crankcase	Bolt (M8)	12 - 15	24 - 26 (2.4- 2.6 kg-m)	17 - 19
	Exhaust cover	Bolt (M6)	3.9-5.9	7.8 - 9.8 (0.8 - 1.0 kg-m)	5.8-7.3
	Compressor head	Bolt (M6)		7.8 - 9.8 (0.8 - 1.0 kg-m)	5.8-7.3
	Throttle body	Bolt (M6)		7.8 - 9.8 (0.8 - 1.0 kg-m)	5.8-7.3
	Air box	Bolt (M6)		7.8 - 9.8 (0.8 - 1.0 kg-m)	5.8-7.3
	Water temperature sensor	-		20 - 23 (2.0 - 2.3 kg-m)	5.8-7.3
	Driven pulley	Nut, 10 (M10)		44 - 49 (4.5 - 5.0 kg-m)	5.8-7.3
	Drive pulley	Nut pulley (M30)		90 - 110 (9 - 11 kg-m)	15 - 17
	Flywheel	Nut, 18 (M18)		140 - 160 (14 - 16 kg-m)	32 - 36
	Adapter, hose joint	-		14 - 16 (1.4 - 1.6 kg-m)	65 - 80
	Nut, hose joint	-		14 - 16 (1.4 - 1.6 kg-m)	102-116
	Valve core	_			41194
				0.4 - 0.6 (0.04 - 0.06 kg-m)	10 - 12
	Spark plug			25 - 30 (2.5 - 3.0 kg-m)	
Lower unit	Cylinder block and	Bolt (M8)			0.3-0.4
				19 - 21 (1.9 - 2.1 kg-m)	18 - 22
	Bevel gear B	Nut, bevel gear B (M12)		40 - 58 (4 - 6 kg-m)	14 - 15
	Stem bracket	Nylon nut 7/8		24 - 26 (2.4 - 2.6 kg-m)	
	Mount rubber, upper	Bolt (3/8)		30 - 34 (3.0 - 3.5 kg-m)	29 - 44
	Mount rubber, lower	Nylon nut (M12)		40 - 44 (4.0 - 4.5 kg-m)	17 - 19
	Gear case	Bolt (M8P1.25)		19 - 21 (1.9 - 2.1 kg-m)	22 - 25
	Propeller nut	-		29 - 39 (3.0 - 4.0 kg-m)	29 - 33
	Fuel connector	-		5.0 - 6.9 (0.5 - 0.7 kg-m)	14 - 15
	Ranyard stop switch	-		2.0 - 2.5 (0.2 - 0.25 kg-m)	22 - 29
Power trim and tilt	Reserve tank bolt	Hexagon socket head screw (M5)		4.4 - 4.9 (0.45 - 0.5 kg-m)	3.6 - 5.1
	Tank cap	-		0.8 - 1.5 (0.08 - 0.15 kg-m)	1.5 -1.8
	Manual valve	-		1.5 - 2.0 (0.15 - 0.2 kg-m)	3.2 - 3.6
	Oil pump bolt	Hexagon socket head screw (M5)		4.9 - 5.4 (0.5 - 0.55 kg-m)	0.6 - 1.1
	Joint metal	-		39 - 49 (4.0 - 5.0 kg-m)	1.1 - 1.5
	Motor bracket screw	-		4.9 - 6.9 (0.5 - 0.7 kg-m)	3.6 - 4.0
Standard torque	M4			1 - 2 (0.1 - 0.2 kg-m)	29 - 36
	M5			3 - 4 (0.3 - 0.4 kg-m)	3.6 - 5.1
	M6			5 - 6 (0.5 - 0.6 kg-m)	1
	M8			11 - 15 (1.1 - 1.5 kg-m)	2 - 3
	M10			23 - 30 (2.3 - 3.1 kg-m)	3 - 5
					8 - 11
					17 - 22

Remark: Tightening order of cylinder head cover and cylinder head is ①▸②▸③▸④.

5. Special Tools

1. List of Special Tool

 Pressure gauge assembly 3T5-72880-O	 Crimping pliers 3T5-72864-O	 Drive pulley press 3T5-72868-O	 Piston slider 3T5-72871 -0
For measuring air rail fuel and air pressure	For crimping OETIKER make clamps.	For press fitting in the drive pulley.	For installing the piston in the air compressor.
 Crankshaft holder 3T5-7281 5-0	 0-ring setting tool (024) 3T5-72863-O	 Piston ring wrench 353-72249-0	 Piston pin tool 345-72215-0
For removing and tightening on the pulley nut.	For installing 0-rings on the fuel injectors.	For installing and removing the piston rings.	For installing and removing piston pins.
 Backlash measuring tool		 Thumbing gauge 3C8-72250-O	 Filler gauge 353-72251-0
For measuring backlash between bevel gears A and B.		For measuring between bevel gears A and B.	For measuring clearances.
 Bevel gear A bearing puller assembly 345-72224-2	 Bevel gear A bearing Setting tool 3C8-7271 9-0	 Bevel gear B nut wrench 346-72231-0	 Bevel gear B nut socket 346-72232-0
For removing bearing from bevel gear A.	For installing bevel gear A bearing.	For removing and installing bevel gear B nut.	

<table>
<tr><td> 
Drive pulley puller assembly
3T5-72890</td><td> 
Flywheel puller kit
3C7-7221 1-1</td></tr>
<tr><td>For removing drive pulley.</td><td>For removing and installing flywheel.</td></tr>
<tr><td> 
Needle bearing puller kit
3C8-72700-O</td><td> 
Spring pin tool A
345-72227-0</td><td> 
Spring pin tool B
345-72228-0</td></tr>
<tr><td>For removing and installing gear case needle bearing and propeller shaft housing.</td><td colspan="2">For removing and Installing spring pins.</td></tr>
<tr><td> 
Clutch pin snap tool
345-72229-0</td><td> 
Bearing Outer race press kit
3B7-72739-0</td><td> 
Clamp ass’y
3B7-72720-0</td></tr>
<tr><td>For installing clutch pin snap ring,</td><td>For installing Outer race of level gear</td><td>For gear backlash measurement</td></tr>
</table>

2. Using the Special Tool

①Pressure Gage Assembly

Measuring Fuel and Air Pressure

1. **Mover the lever for cock (3T5-72883-O) to position A shown in the figure below.**
2. **Screw adapter B (3T5-72884-0) into either the air or fuel pressure measuring valves located on the air rail.**

Caution:

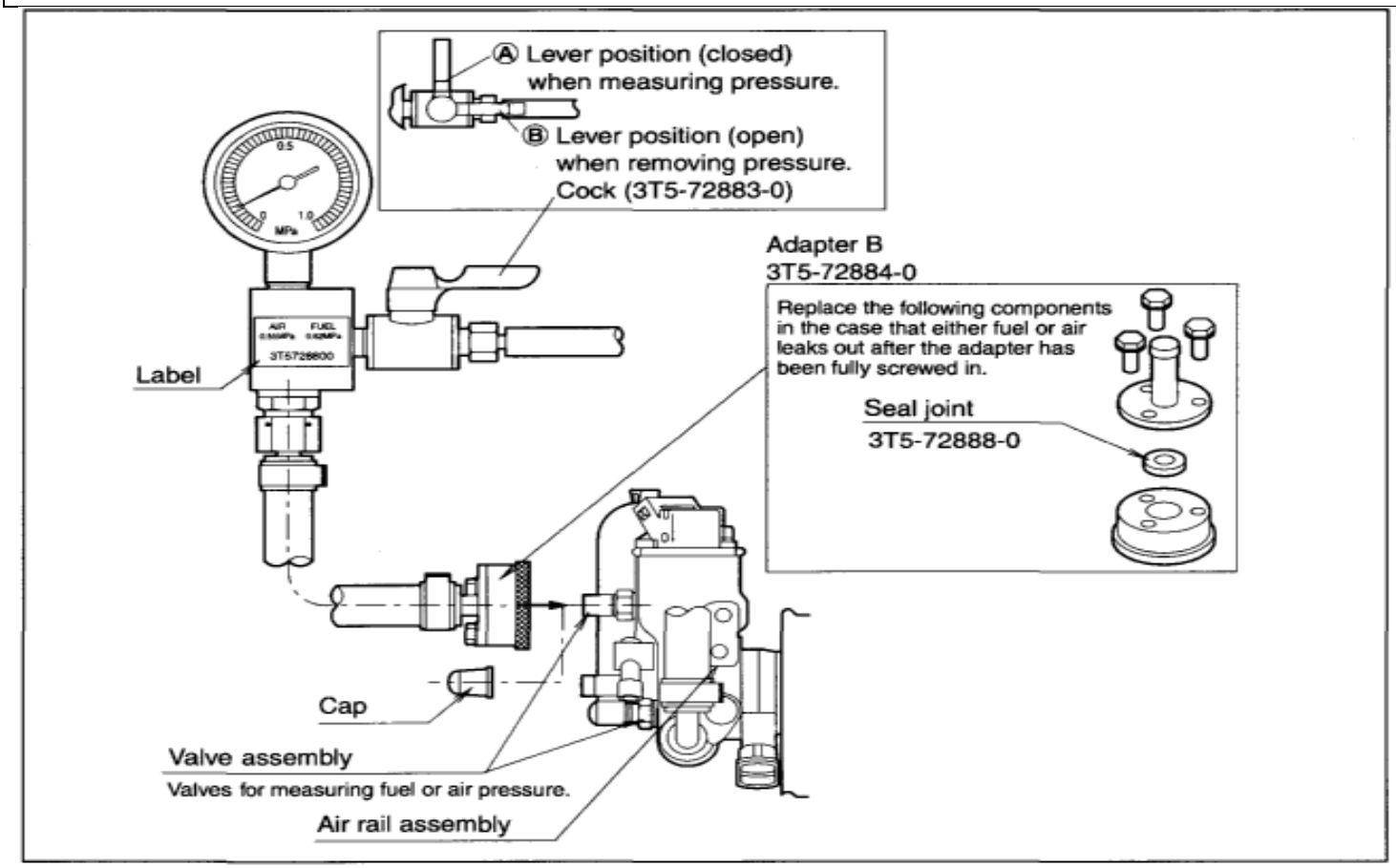
A small amount of fuel will spurt out as the adapter is inserted in the fuel measuring valve.

3. **With the ignition key set the OFF position, turn it to START to activate the starter motor and turn over the engine for approximately 15 seconds. (Once the engine starts, allow it to idle at 700 rpm for approximately for 15 minutes.)**
4. **If both fuel and air pressure values fall within the standard (rated) range, engine operation is normal. (If not, service the engine by referring to the relevant sections in this manual.)**

PRESSURE	Rated value (kPa, psi)	Rated range (kPa, psi)	Remarks
AIR PRESSURE	550, 80	550 ± 30, 80 ± 4	Pressure falls when engine stops turning over.
FUEL PRESSURE	620, 90	620 ± 30, 90± 4	

5. **When finished measuring, turn the lever to position B (open) to relieve internal pressure; then remove adapter B from the measuring valve.**

It is important to have a container handy. Once fuel measuring completes and the lever is set to position B (open), a certain amount of fuel will spurt out from the hose (98AB-5-0200). Be sure to point the hose (98AH-8-1 000) on the cock side lower than valve position and drain all remaining fuel prior to removing adapter B.



②Crankshaft Holder (3T5-7281 5-0)

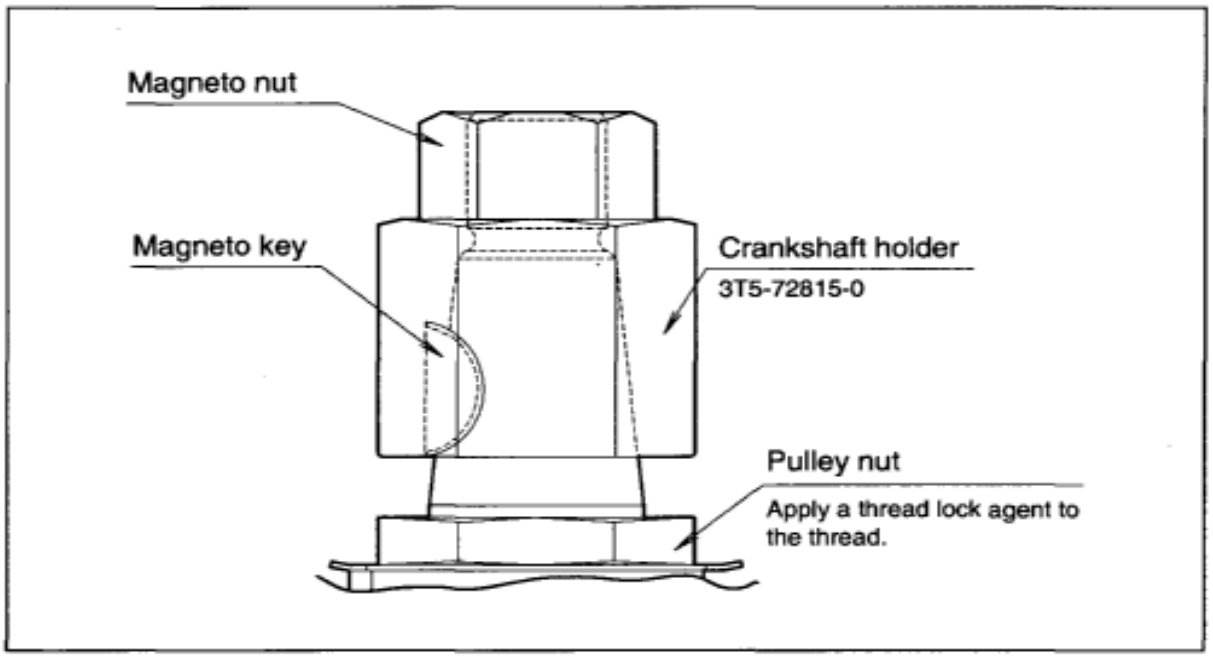
Removing Pulley Nut

1. Disassemble the flywheel. (Refer to section ①of this chapter.)
2. Install the magneto key and crankshaft holder for this engine.
3. Use the magneto nut to secure the crankshaft holder in place. (The magneto nut is threaded clockwise.)
4. Using two 36 mm wrenches, attach one to the crankshaft holder and use the other to loosen the pulley nut.

Installing Pulley Nut

1. Apply thread lock (Three Bond #1342) to the thread area.
2. Screw the pulley nut onto the crankshaft by hand.
3. Install the engine's magneto key; then install the crankshaft holder.
4. Use the magneto nut to secure the crankshaft holder in place.
5. Using two 36 mm wrenches, attach one to the crankshaft holder and use the other to tighten on the pulley nut, adjusting it to the torque shown below.

Tightening Torque: 90 to 110 N-m (9 to 11 kg-m) [65 to 80 lb-ft]



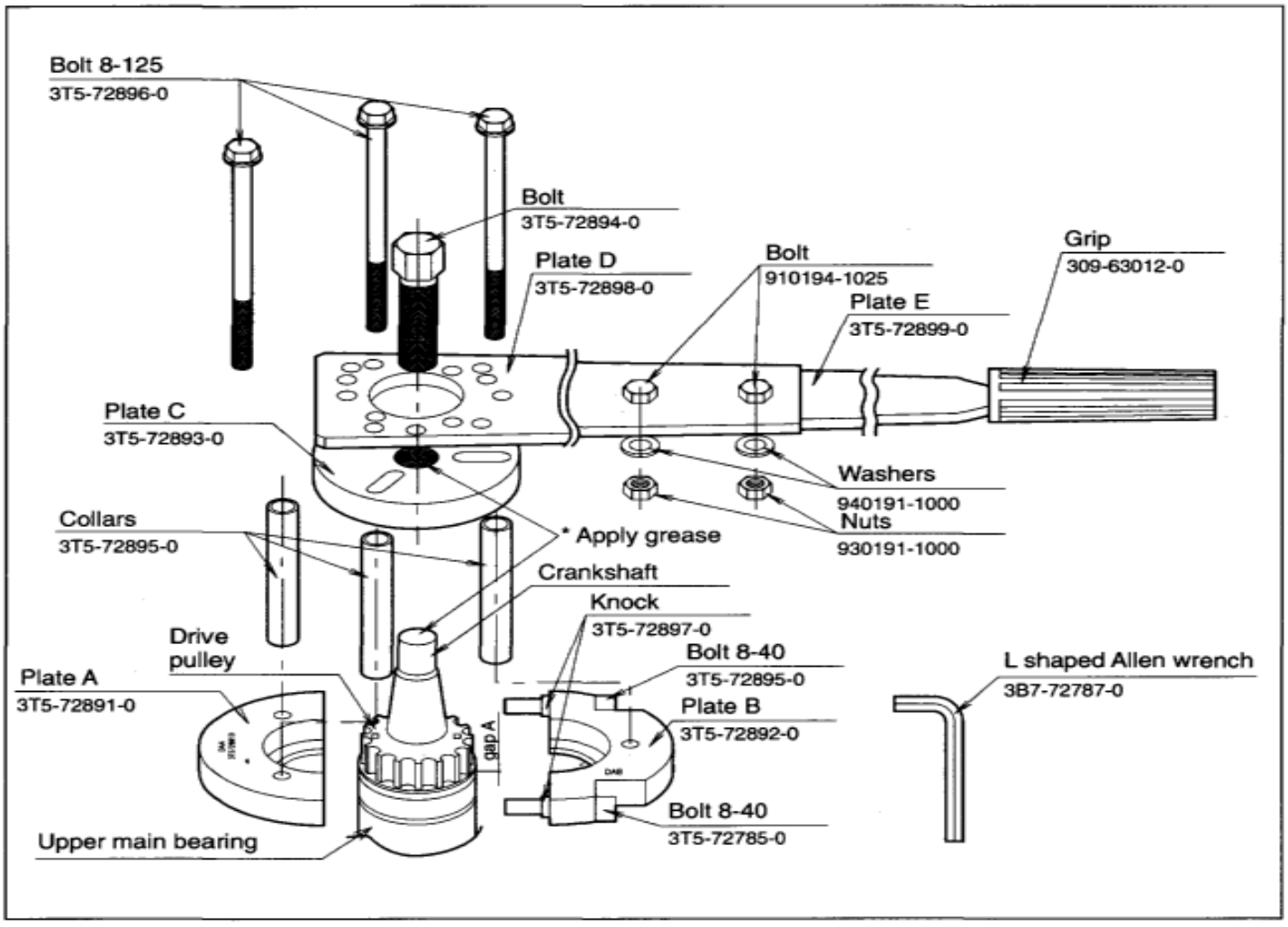
③Drive Pulley Puller Assembly

Removing Drive Pulley

Begin the disassembly operation by removing the crankshaft from the power unit.

1. Remove pulley nut. (Refer to section © of this chapter.)
2. Move the upper main bearing towards the crankshaft end in order to create a gap with the drive pulley.
3. Insert plate A (3T5-72891 -0) and plate B (3T5-72892-0) into the gap by mating the two knock studs (3T5-72897-0) on plate B with plate A and tightening evenly the 8-40 bolts (3B7-72785-0) on both sides using the Allen wrench (3B7-72787-0).
4. Insert the three collars (3T5-72895-0) between plate C (3T5-72893-0) and the already joined plates A and B.
5. Using a 19 mm socket wrench, turn the bolt (3T5-72894-0) until the drive pulley comes away.

Note: Apply grease to the sections in the diagram marked by the asterisk (*).



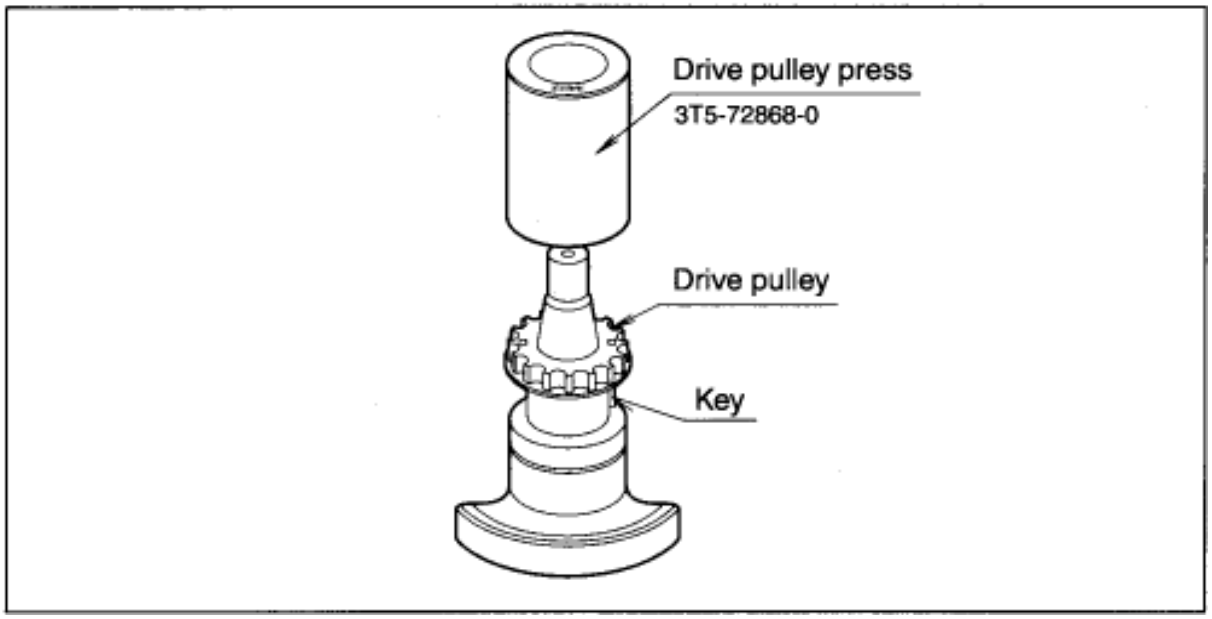
④Drive Pulley Press (3T5-72868-O)

Inserting Drive Pulley

1. Remove any oil or grease from crankshaft and drive pulley hole. Apply Loctite Primer 7471; wait 5 minutes; then apply Loctite 648 to the hole.
2. Insert the half moon key in the crankshaft and install the drive pulley.
3. Position the drive pulley press above the drive pulley.

With the wide-open end of the press facing downward, place down over the drive pulley.

4. Tapping lightly on the top center area of the press with a hammer, press fit the drive pulley in place. (The beginning half is designed to insert easily, the remaining half requires press fitting.)

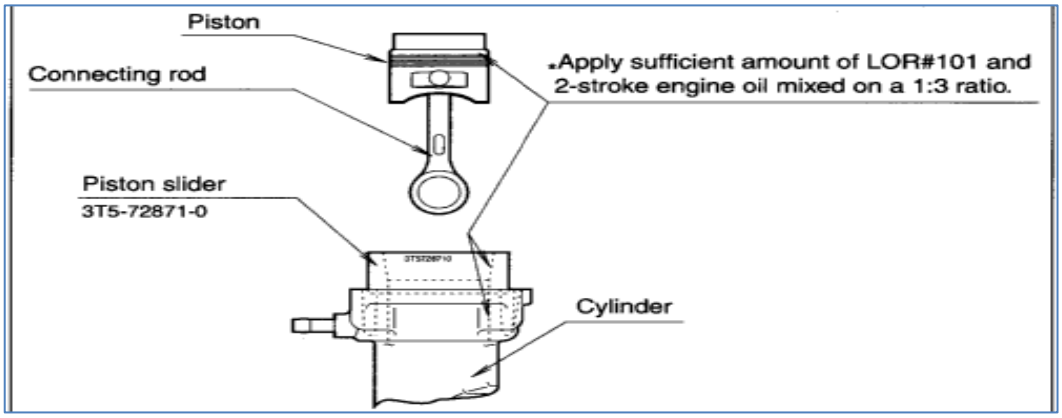


⑤Piston Slider (3T5-72871-O)

Installing Air Compressor Piston

1. Apply sufficient amount of LOR#1O1 and 2-stroke engine oil mixed on a 1:3 ratio to the exterior of the piston, the interior of the piston slider and the interior of the compressor rings.
2. Place the piston with piston ring installed on the tapered part of the piston slider, lineup the assembly with the top surface of the cylinder and press piston into the cylinder by hand.
3. Press the piston down in a single firm motion until it is properly inserted.

Note: If the piston ring should get caught part way through, repeat the operation from step 2.

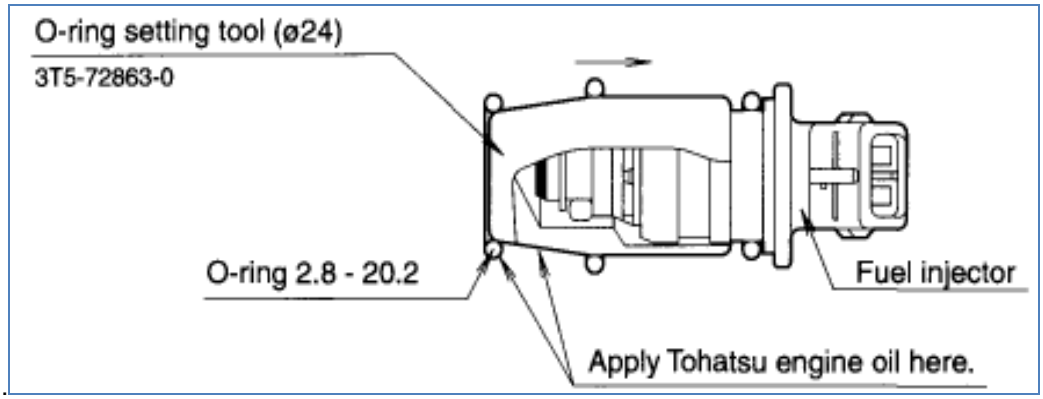


⑥0-ring Setting Tool (o24) (3T5-72863-O)

Install the fuel injector 2.8-20.2 0-rings (3T5-1 0304-0).

Apply engine oil to both the 0-rings and the 0-ring setting tool.

Position the 0-ring setting tool in place; then install 0-rings by sliding them on.



..

⑦Crimping Pliers (3T5-72864-O)

This tool is used to install the specified clamps on the fuel and air system hoses. It is intended for use with the following parts.

1. Fuel Hose Assembly (3T5-1 0089-0)
   Clamp 21/32 (385-10086-0): Installed at four locations on the hose connecting FFP case assembly to high-pressure fuel filter and the hose connecting high-pressure fuel filter to air rail assembly.
2. Air Hose Assembly (3T5-10088-0)
   Clamp 1/12 (3T5-10087-0): Installed at two locations on hose connecting air compressor to air rail assembly.
3. Clamp 29/64 (3T5-10091-0): Installed at two locations on hose connecting L nipple on air rail to fuel regulator.

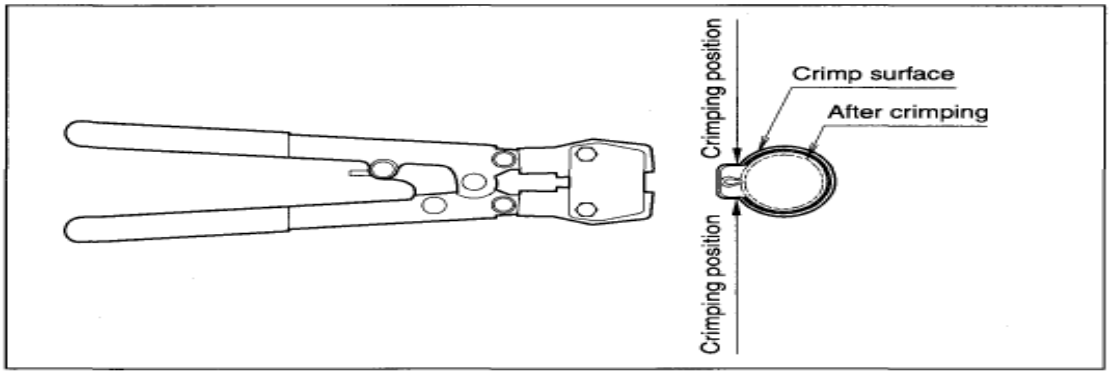
Clamp Crimping Procedure

Crimping is performed by applying crimping forced to the locations indicated by arrows in the figure below.

The crimping tool is designed to not open until it has crimped all the way.

Caution:

- Be sure to use new clamps.
- Note that the highly pressurized fuel or high temperature, highly pressurized air flowing through the hoses are liable to leak if the clamps are not firmly crimped in place.



1. Periodic Inspections

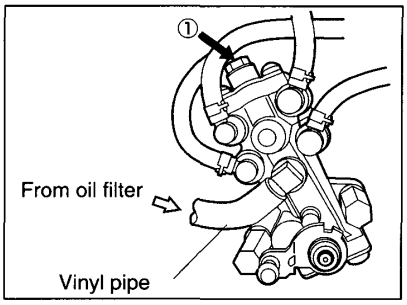
Category	Inspection points	Inspection intervals							Inspection procedure	Remarks
		10 hrs. or bimonthly	30 hrs or monthly	50 hrs. or 3 months	100 hrs. or 6 months	Yearly	1.5 years	200 hrs. or 2 years		
Fuel adn compression systems	High press. Fuel filter			O	O	O	O	Replace		Entire cartridge
	Piping		O	O	O	O	O	Replace	Wear on pipes &leaking connectors	
	Fuel tank				O	O	O	O	Clean	Including filter
	Air filter					O		Replace		
	Drive belt					O		Replace		
	Fuel pressure					O		O		
	. Air pressure		O			O		O		
Ignition system	Spark plug		O		O	O	O	O	Remove carbon Spark gap	0.7 to 0.8 mm (0.0276 to 0.0315 in)
Starting system	Pull Start				O	O	O	O	Salt, Corrison	
	Rope Start				O	O	O	O	Frey in rope	
Lower unit	Propeller	O	O	O	O	O	O	O	Wear, bending &chipping on blades; slipping of cushion rubber	
	Gear oil	Replace		O	O	O	O	O	Replenish or change oil,check for water leakage	
	Water pump			O	O	Replace	O	Replace	Wear and cracks on impeller & liner	
Oil systems	Oil tank	O			O	O	O	O	Oil leaks, damage faulty clip; wash filter	
	Oil pipes	O			O	O	O	O		
	Oil filters	O		O	O	O	O	O		
Warning system				O	O	O	O	O		
Nuts and bolts		O	O	O	O	O	O	O	Tighten	
Sliding & rotating parts, grease_nipples					O	O	O	O	Apply or inject grease	
Standard tilt		O			O	O	O	O	Check & replenish oil; manually operate	
Anodes				O	O	O	O	O	Check for corrosion, .warping and wear	

Note: The manual recommends the engine be overhauled after every 300 hours of operation

2. Inspecting Engine Oil System

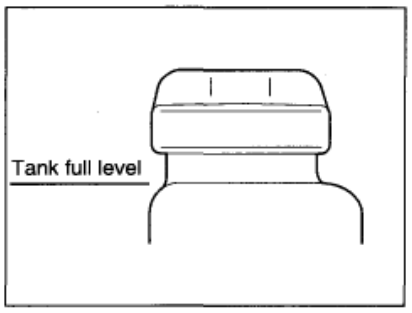
Bleeding Air from Oil Pump

Conduct a visual check of the clear vinyl pipes connecting the oil pump to the oil tank to inspect for the presence of air. Bleed hoses if necessary.



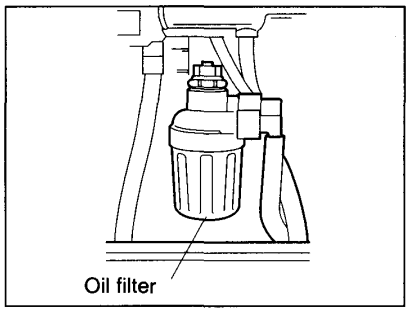
Do this by loosening the air vent screw① on the air pump and bleed until all air has been removed from the piping.
Use a cloth to wipe away the bled oil.

Note that the air may not bleed out properly if the oil in the tank is too low. Make sure to fill the tank prior to bleeding air from the piping.



Oil Filter and Oil Tank

Check the oil filter for water and foreign matter. If present, disconnect all piping connecting the oil tank to the oil pump from the outboard engine and remove all oil and any water or foreign matter. Reconnect oil tank and add new oil; then repeat the same air bleeding procedure used on the oil pump

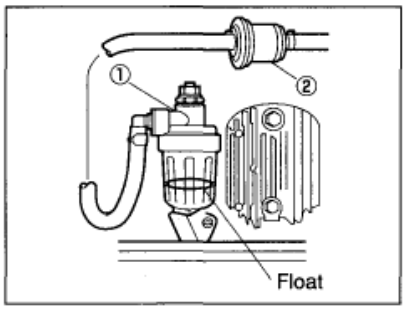


3. Inspecting Fuel System

Replacing Engine Fuel Filter

①Fuel filter (Detachable type)

The red ring ①floats when water is present. If it floats, remove cup and empty out the water.



②High-Pressure Fuel Filter (Disposable type)

Refer to maintenance chart.

Cleaning Bladder/Fuel Tank Filter

①Fuel pickup elbow

②Filter

Turn① to the left to remove and clean②.

Cleaning Bladder/Fuel Tank.(Not supplied with RAIDER)

Clean the bladder/fuel tank whenever there is a buildup of water or foreign matter.

1. Inspecting Compression System

Measuring Procedures

Use the following procedures to measure the compression of the individual cylinders.

1. Fully charge the engine battery (optional).
2. Start engine and idle for 3 minutes to warm.
3. Unlock the stop switch.
4. Remove all spark plugs.
5. Remove all air injector ② and fuel injector ③connectors.

Accurate compression readings are only possible when all ②&③connectors are disconnected. It should also be noted that the ECU records detailed information on which connectors were disconnected during each inspection. Refer to the section on the TLDI self-diagnosing function for more information.

6. Attach the compression gauge ④into the sparkplug hole (only one at a time).
7. Use the starter motor to turn over the engine.

Engine speed: approx. 400 rpm for at least 5 seconds

(Note that throttle position does not affect compression readings.)

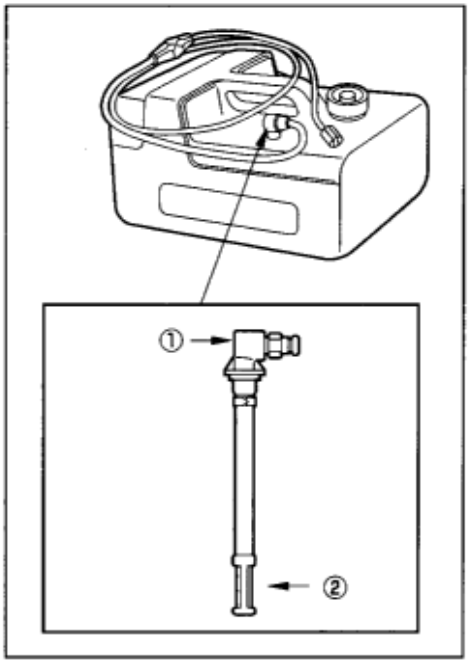
- Measure the compression for all cylinders
- Confirm that all compression readings conform to specifications.

Rated compression:
830 kPa (8.5 kg/cm², 120 psi)
±10%

Results and Steps to Take

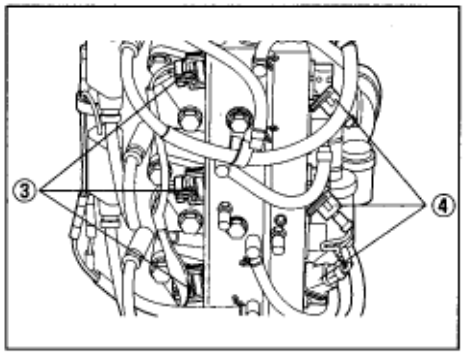
Repair or replace components as necessary when the readings fall under the following categories.

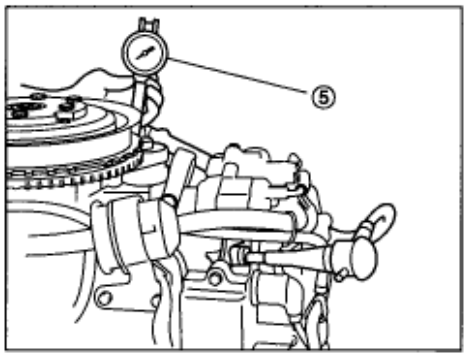
- Below specified compression:
- Difference between cylinders



exceeds 103 kPa (1.05 kg/cm², 15 psi)

- Compression is abnormally high.



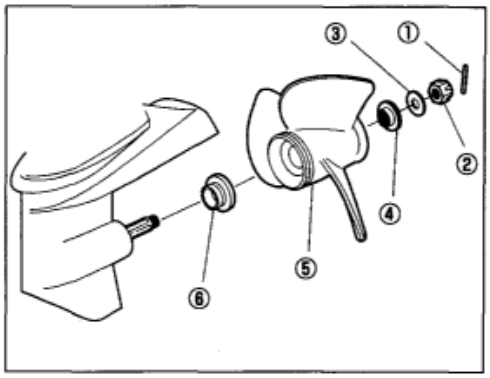

5

2. Inspecting Gear Case Area

- To avoid accidental starting of engine while servicing, twist and remove all spark plug leads.

Replacing Propeller

Worn or bent propeller blades will not only affect performance and can also lead to engine damage.



- Move the shift lever to the neutral position; stop the engine, then replace the propeller.
- Be sure to wear a thick pair of gloves and proceed carefully.

Remove the following components

① Split pin.⇨Replace with new pin

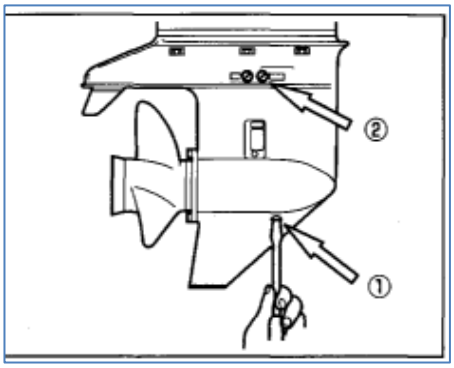
②Propeller nut

③Washer

④Propeller stopper or adapter

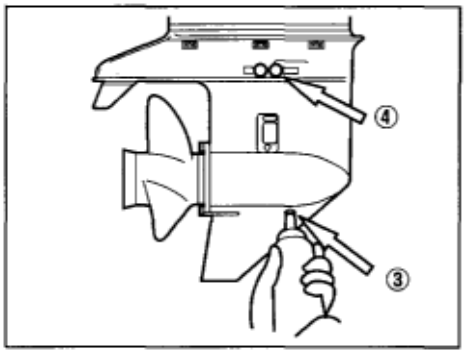
⑤Propeller or with drive sleeve

⑥Propeller thrust holder or washer



Replacing Gear Oil

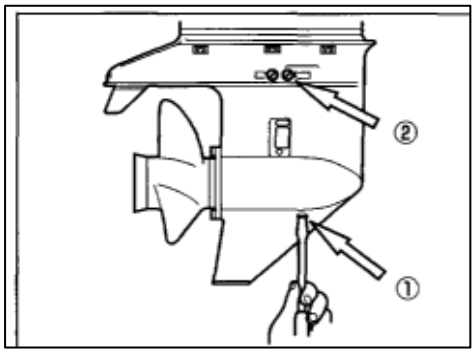
- Place an oil container under the lower unit and remove the lower oil plug①
- Remove the upper oil plug ②and sufficiently drain the oil.



- Insert the gear oil container spigot t③ into the lower oil plug hole and squeeze the container until oil overflows from the upper oil plug hole④.

Oil: Genuine gear oil or GL5, SAE#80, #90
Capacity: 500m1, 16.9 US fl.oz (approx.)

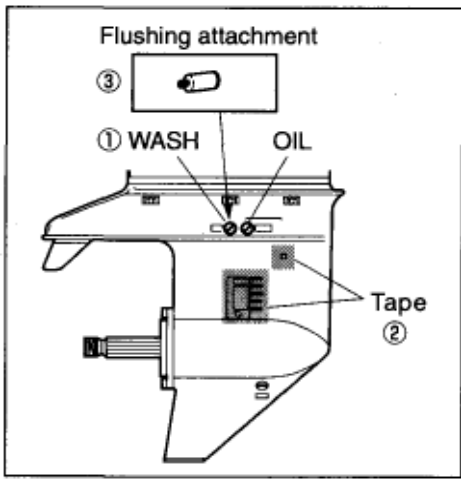
First tighten the upper oil plug②; then remove the oil container and reinstall the lower oil plug①.



Corrosion Protection

Whenever possible after use in sea water or submersion in sea water, wash entire engine with fresh water to remove salt deposits and wipe down with a dry cloth. Spray entire powerhead with a liberal coat of Anti-Corrosion Spray penetrant/lubricant or equivalent.

Though not specifically mentioned as a service procedure,
Anti-Corrosion Spray or equivalent should be applied after any service repairs under the engine cover and repeated at regular intervals to protect powerhead components. Anti-Corrosion Spray leaves a thin, non-messy, transparent film that actually lifts water and moisture from metal surfaces. It protects equipment and tools that are left outdoors, even in humid coastal areas. Anti-Corrosion Spray dries out ignition systems to start wet engines and stops moisture-induced short circuits in electrical systems.



3. Washing Procedure

Take care not to come into contact with the propeller while it is in motion. Be sure to remove the propeller when operating the engine on land.

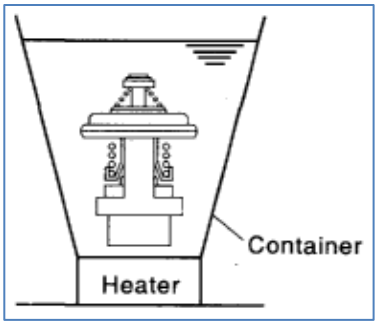
Be sure not to operate the engine in confined areas, such as a boat house, as the exhaust fumes contain toxic carbon monoxide gas.

Washing With Flushing Attachment (Hose adapter)

Remove the following components.

- Propeller and thrust holder, etc.

①Water plug

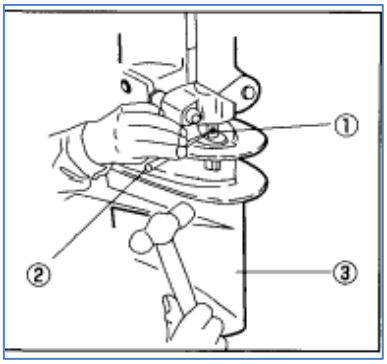


Install the following components.

②Tape: at 2 locations (on water strainer)

②Flushing attachment

- Connect a hose to a water faucet and insert the end of the hose into③
- Move the gearshift lever to the neutral position and start the engine.
- Confirm that a steady stream of water is coming from the water checking port; then operate the engine at low speed for 3 to 5 minutes.
- Stop the engine, turn off the water supply, remove the flushing attachment ③and tape, reinstall the water
- plug① ; then reinstall the propeller assembly.

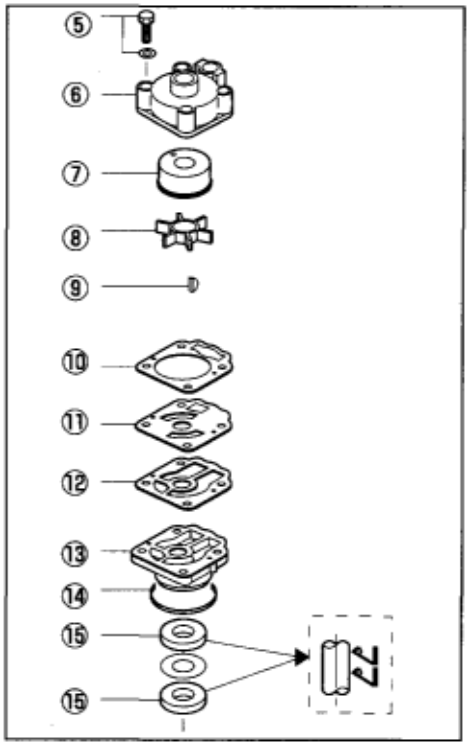


4. Inspecting Cooling System

Thermostat test

- Place the thermostat into a suitable container and add either cold or warm water.
- Heat the water in the container and confirm that the thermostat valve operates when the temperature rises.

Valve operation start temperature	52°C ± 1.5°C (126°F ± 3°F)
Valve full open temperature	65°C ± 1.5°C (149°F ± 3°F)
Valve full open lift	3 mm or more



Replacing Pump Impeller

Remove the following components.

① Split pin

Special tool	② Spring tool A
	345-72227-0

Remove the following components.

- Bolt: type H835 at 6 locations
- Remove the gear case assembly ③ from the drive shaft housing.

⑤Bolt: type H835 at 4 locations

Inspect the following components.

⑥Upper pump case

⑦Pump case liner

⑧Pump impeller ⇨ Replace with new one.

⑨Key for water pump impeller

⑩Gasket for pump case ⇨ Replace with new one

⑪Guide plate for water pump

⑫Gasket for guide plate ⇨ Replace with new one

⑬Lower pump case

⑭0-ring

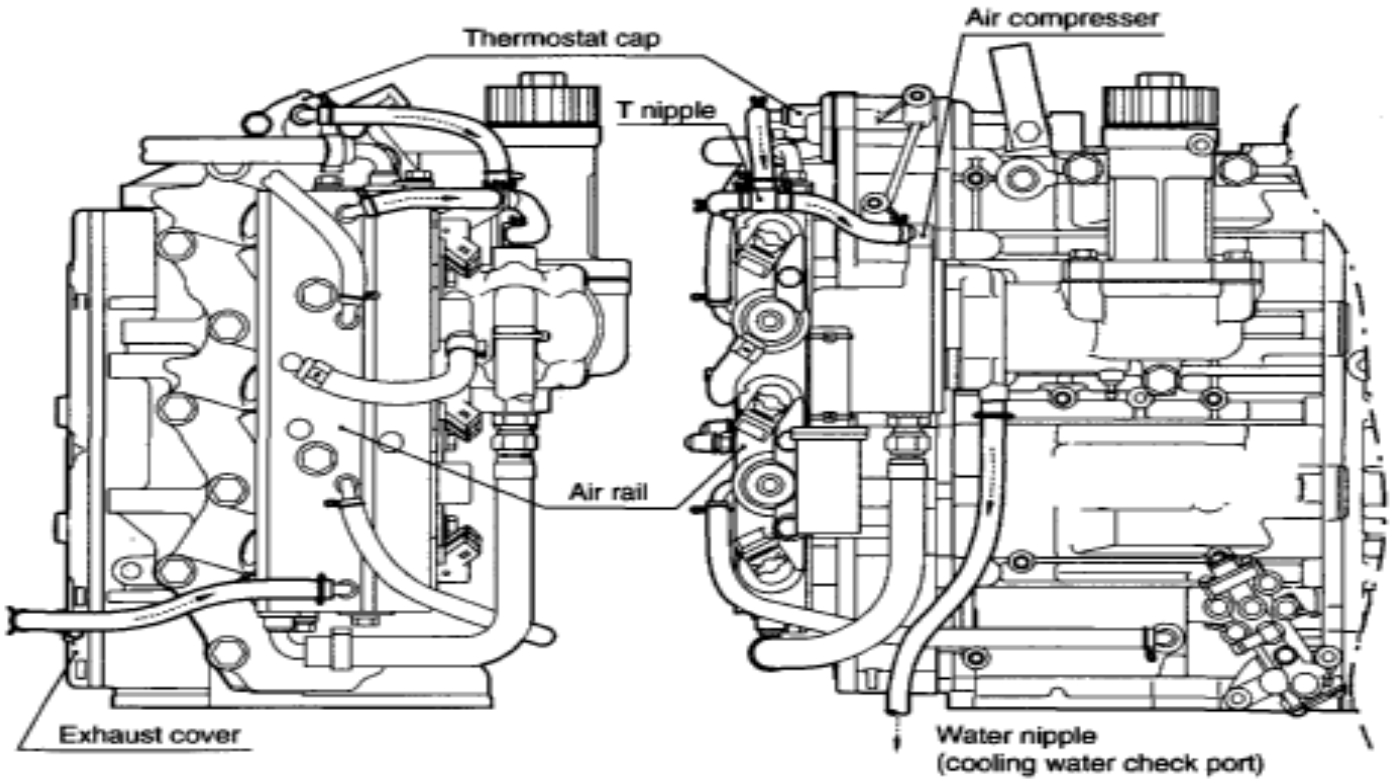
⑮Oil seal

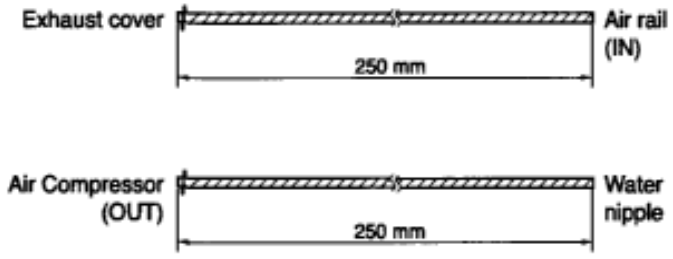
Inspection Procedure

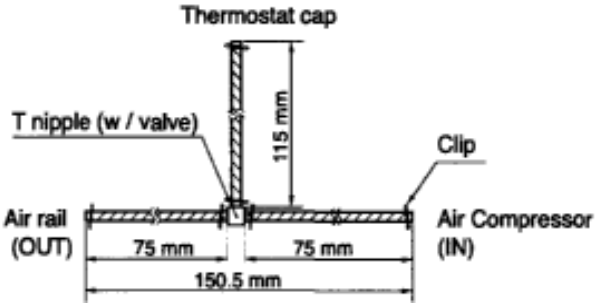
⑥- ⑮replace with new components if worn or damaged.

Make sure oil seals ⑮are installed facing in the proper direction.

Overview of Cooling System





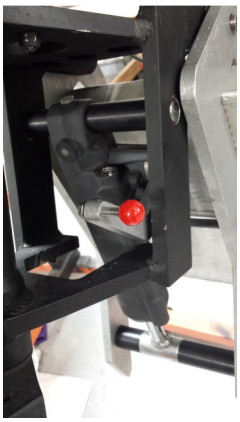


Tubing

5. Inspecting Tilt System

Checking Lift Cylinder

Note that the lift cylinder is located in the front of the Raider Outboard is checked by first tilting up the outboard engine to confirm the motor can tilt easy. The cylinder should work freely. No maintenance can be completed on this item as it is a replaceable. At the back of the Raider insure all lock handles work freely.



Caution:

In order to avoid damage and accidental injury that can occur when the tilted up (for storage and inspections etc.) outboard engine accidentally tilts back down, be use to insert the tilt stopper when tilted up.

Oil Type – Two Stroke Only. Insure oil is full prior to submersion.

Note that the presence of air in the oil can cause the engine harm during submersion as water could penetrate oil system

With the outboard engine installed on the boat, turn the red knob (counter clockwise) and move the engine the full tilt up and down stroke 5 or 6 times; then turn the red knob back to the starting position (clockwise).

6. Inspecting Air Rail Pressure

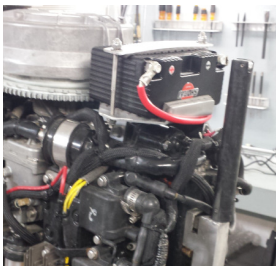
Refer to the description for ~ Pressure Gauge Assembly, listed under section 5. (Special Tools) in Chapter 2 (Servicing Information).

7. Inspecting the Dewatering System

The dewatering system consists of three valves that requiring opening after submersion. The first valve is located in the back of the Raider Outboard. Simply lift the lever on the back assembly and turn 1/4 turn to open the valve. Check to insure the valve turns freely.Inspect the mid valve located on the left side of the Raider outboard by turning the valve 1/4 turn. The valve should operate freely. Inspect the front valve to insure it turns freely. Turn the valve ¼ turn counterclockwise. The valve should operate freely. Return to closed position by turning ¼ turn clockwise.

8. Inspecting Battery System

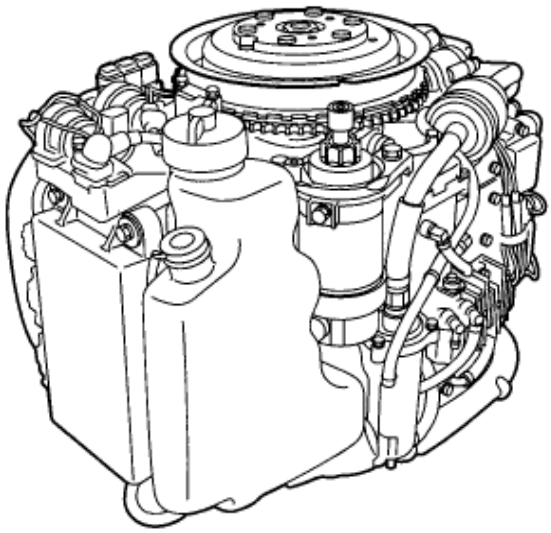
The battery is located under the cowl behind the flywheel. The battery should be inspected for corrosion at the positive and negative terminals. The cowling must be removed for this inspection. The battery is a simple lead acid, sealed, battery. Test the battery by pushing the starter button located on the front of the Raider pan. The Raider should turn over freely. Do not start unless in water. If the motor fails to turn over replace the battery.

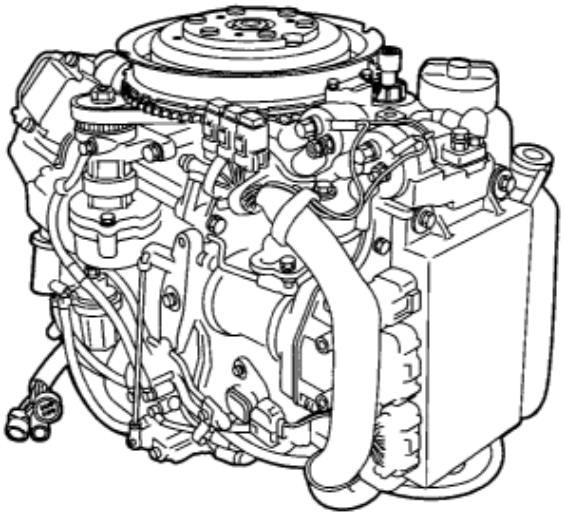


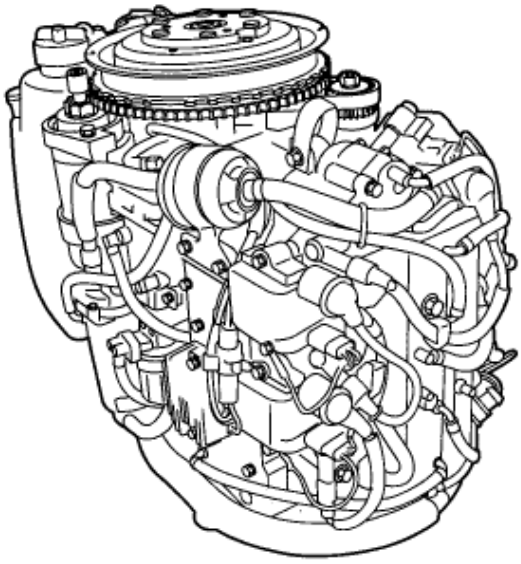
CHAPTER 4 DISASSEMBLING, INSPECTING AND REASSEMBLING POWER UNIT .....

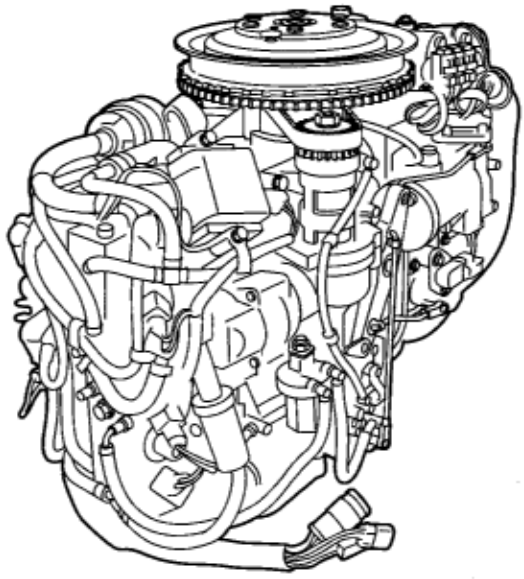
4

1. Power Unit







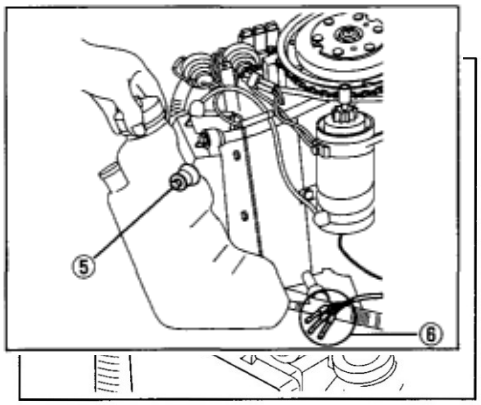


a) **Removing Power Unit**

Disassemble the following components.

- Fuel connector
- Battery
- Ring gear cover

④Battery cable (Optional on Raider)



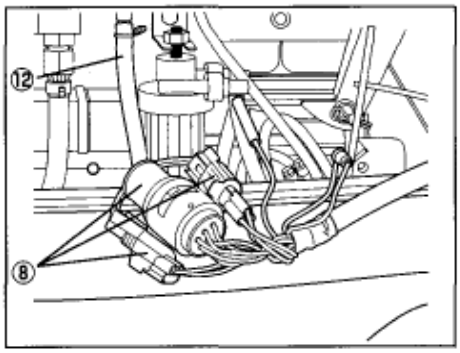
Disassemble the following components.

Begin by disassembling the oil tank;

⑤ Oil tank mounting bolts

- Fuel hose (remove from fuel filter inlet)

Reinstall the oil tank with oil tank mounting bolts after then.



P Type

Disassemble the following components.

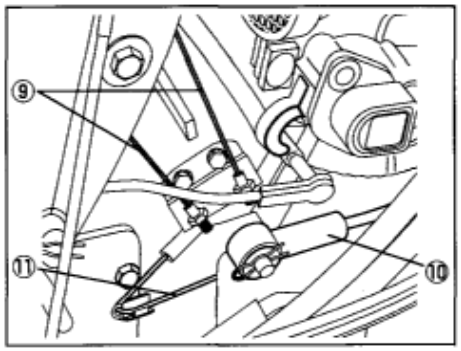
⑧Wire harness connectors: 3

⑨Throttle cable from advancer arm

⑩Shift cable from shift arm

⑫Water hose from compressor

- Ground connector from cylinder



F Type

Disassemble the following components.

⑧Wire harness connectors: 3 Neutral switch cable

⑨Throttle cable from advancer arm and throttle cable bracket.

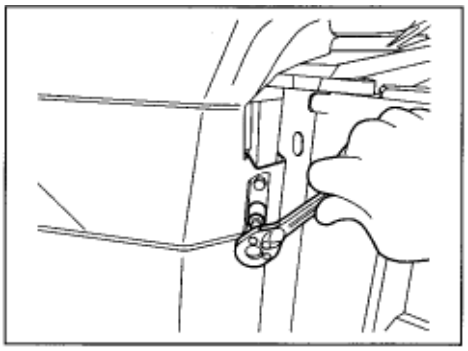
⑩Shift cable joint rod from shift arm

⑪"S"- link from throttle stop arm

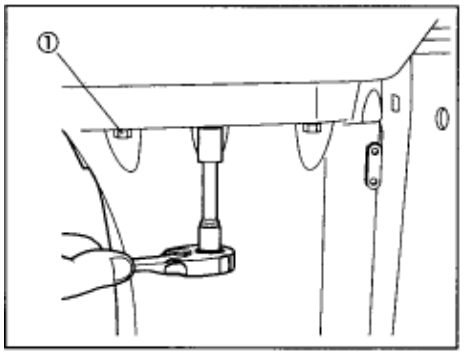
⑫Water hose from compressor

- Ground connector from cylinder

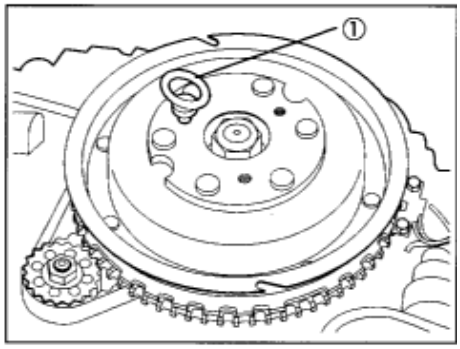
Disassemble apron (splash pan).



Remove engine mounting bolts.
①Bolt: type H880 at 6 locations

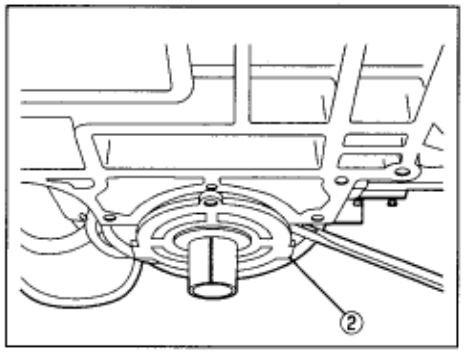


Secure eyebolts①to the flywheel; then use a sufficiently strong hoist to suspend the power unit while keeping it in the horizontal position.



Suspend slowly, taking care not to catch the power unit on any of the wiring or hoses.

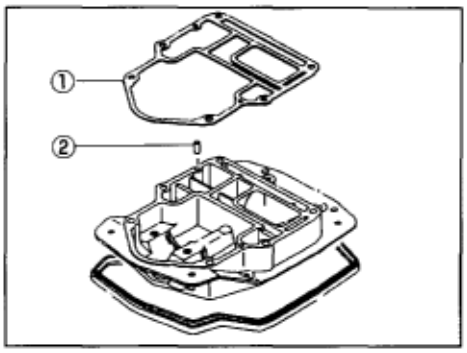
②Remove crankcase head.
Remove with caution by gently inserting a flathead screwdriver in the groove



Inspect the following components.

• Oil seals: at 2 locations • 0-rings • Replace any damaged components.

b) **Reassembling Power Unit**



Install the following components.

①Install the engine base gasket >Replace with new gasket.

②Knock pin

Apply three bond #1107 (Seal out) to both sides of engine base gasket

Secure eyebolts to the flywheel; then use a sufficiently strong hoist to suspend the power unit while keeping it in the horizontal position.with power unit suspended, install the following components.

- Crankcase head

Apply a sufficient amount of heat-resistant grease (LOR #101) to the entire circumference of the oil seal lip.
Apply a sufficient amount of the recommended grease to the 0-rings.
Refer to servicing information (section 3 in chapter 2)

Place power unit on to engine base.

Take care that none of the wiring or hoses gets caught between the power unit and engine base mating faces.

Referring to section 1), assemble power unit in the reverse order of the procedures described there.

2. Peripheral Parts

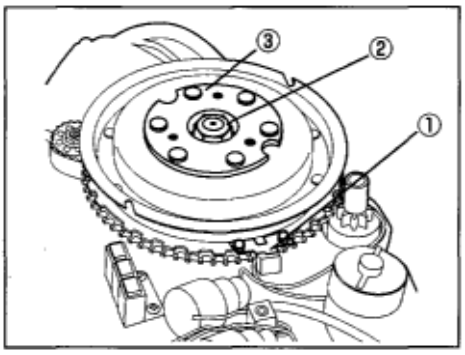
1) Electrical System

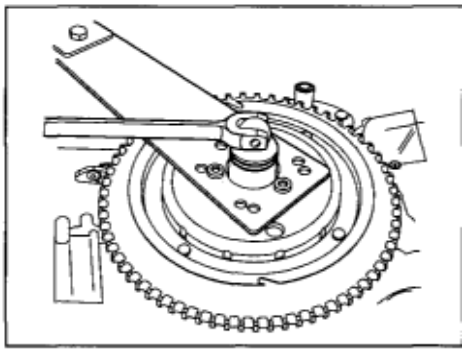
Removing CrankPositioning Sensor (CPS)

,Flywheel and Alternator

Remove the following component.

①CPS

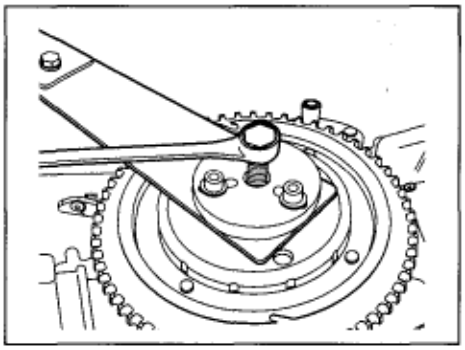




Remove the following component.

②Flywheel nut

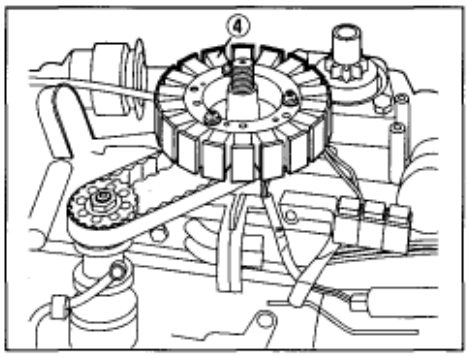
Special Tool	• Plate • Socket wrench: 27 mm • Bolt: type M820



Remove the following component.

③Flywheel

Special Tool	• Flywheel puller kit 3C7-7221 1-1 • Socket wrench: 19 mm



Remove the following components.

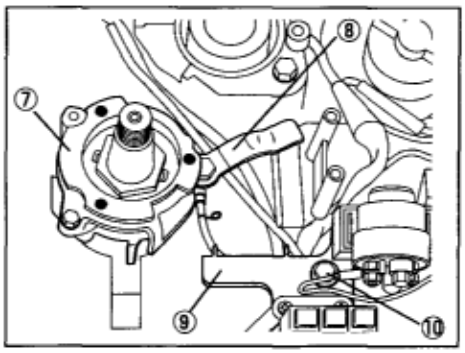
④Alternator

- Alternator coil output lead (3 plugs)

Remove the following components.

⑦Coil bracket

⑧Cable clamp



Remove the following components.

⑨Solenoid switch bracket

⑩Bolt: type H625 at 3 locations

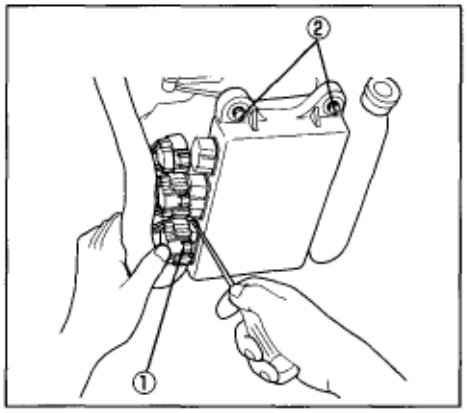
Removing ECU *

*ECU: abbreviation for the engine control unit.

Remove the following components.

①ECU connector

While pressing down on hook, remove by prying gently with a flathead screwdriver.



②Rubber mount bolt: type H630 at 3 locations Remove from 2 of the upper 3 locations; then take out ECU by pulling it upwards.

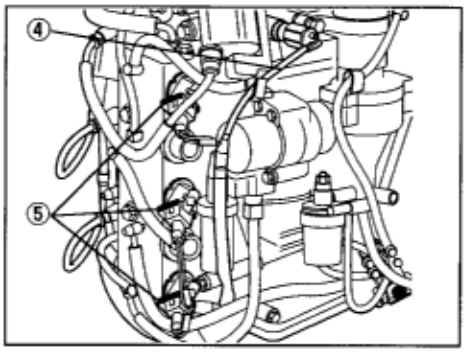
The collar used on the ECU rubber mount differs in length from the one used on the oil tank.

③Clamp

Removing Harness Assembly

Remove the following components.

Remove harnesses in order starting from remote control side.



④Water temperature connector

- Remove by pressing down on hook and pulling out connector.

⑤Fuel injector connector

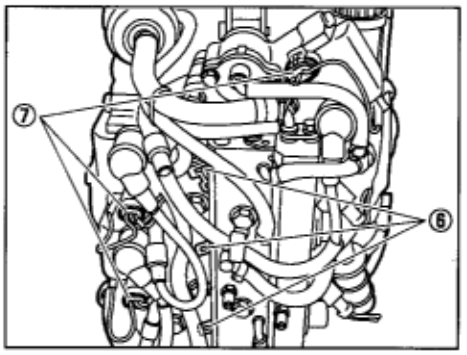
- Remove by pressing down on wire hook and pulling out connector.

⑥Air injector connector

- Remove by pressing open the claws on either side with a flathead screwdriver and pulling out.

⑦Bullet connectors for ignition coils

When removing cable assembly with the compression head resting on the engine base, be sure to remove the air rail bolt to free the air rail.

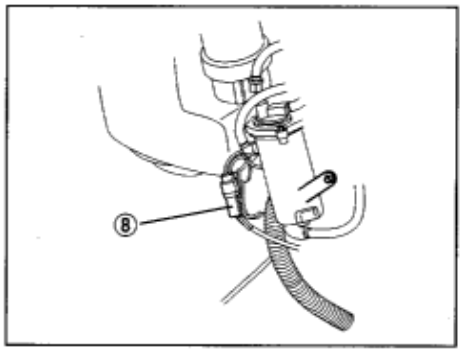


Remove the following components.

⑧FFP*connector

- Remove by pressing down on hook and pulling out connector.

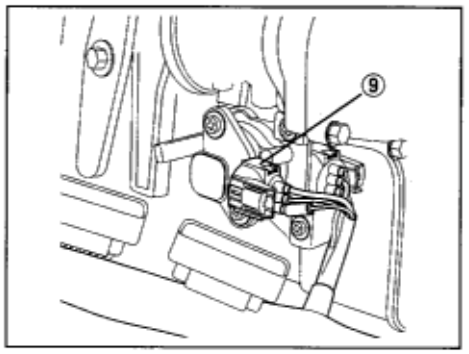
  * FFP: abbreviation for fuel-feed pump.



⑨TPS·connector

- Remove by pressing down on hook and pulling out connector.

  *TPS: abbreviation for throttle position sensor.



Removing Ignition Coil and Rectifier Regulator

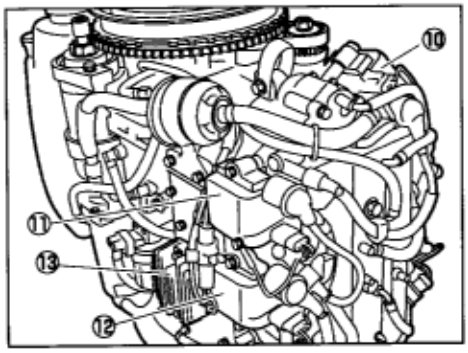
Remove the following components.

⑩Ignition coil #1

⑪Ignition coil #2

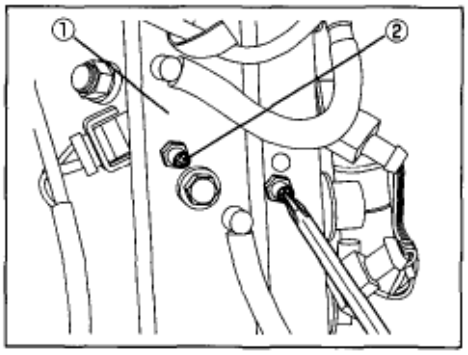
⑫Ignition coil #3

⑬Rectifier regulator



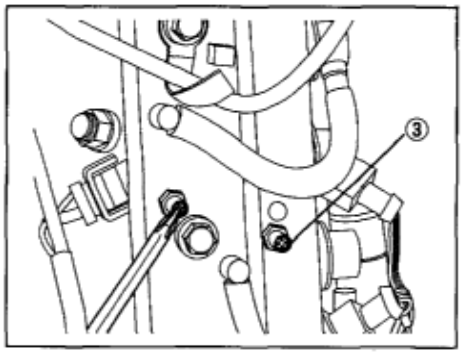
2) Air Supply System

Prior to Removing Peripheral Components



(1) Press on the core of the air valve ② located on the air rail ① to release pressure from the air lines.

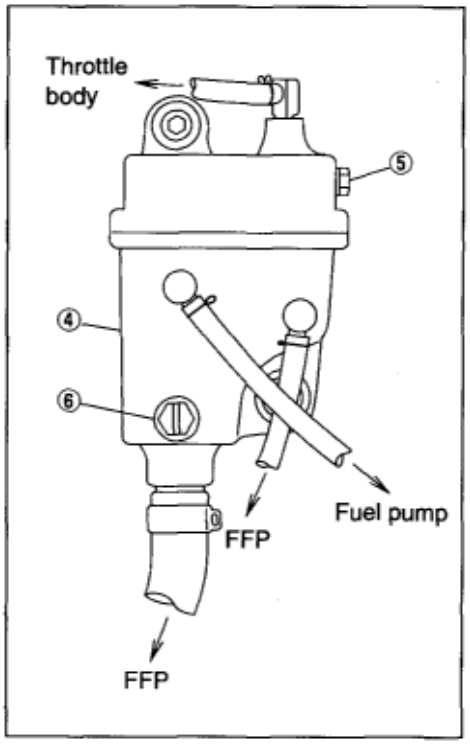
(2) Press on the core of the fuel valve ③ located on the air rail ① to release pressure from the fuel lines.



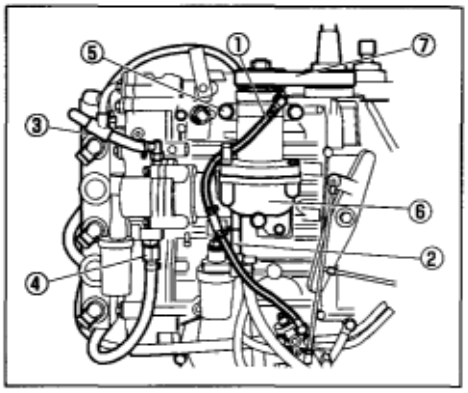
Be sure to cover the fuel valve with a clean cloth as fuel will spurt out when pressure is released

(3) After loosening the plug ⑤ on the upper section of the vapor separator ④in order to release pressure, loosen the drain plug ⑥ on the lower section and drain out the fuel.

Hold a cloth against the drain plug to absorb the fuel as it drains out.


Throttle body
5
4
6
Fuel pump
FFP
FFP

Removing Air Compressor



Remove the following components.

①Detach the oil pipe on the compressor side.

②Detach recirculation pipe on the compressor side.

③Detach cooling water pipe on compressor side.

④Remove air hose on compressor side.

⑤Compressor bolts: at 3 locations

Remove the following components.

⑥Air compressor

The air compressor is held in place by two knock pins, these should be removed with a gentle tilting motion

⑦Drive belt

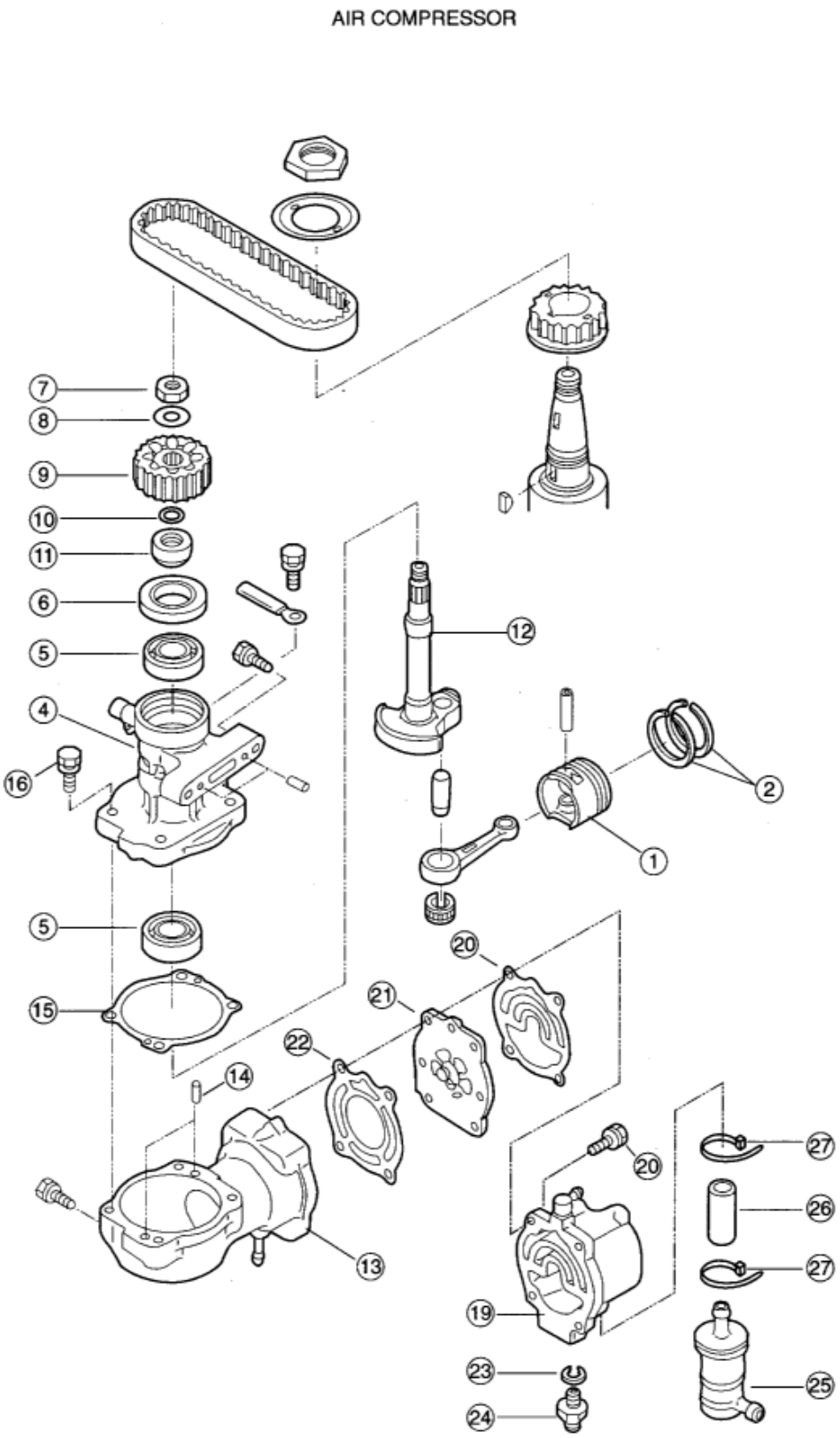
Be sure to apply markings that identify the top and bottom sides in cases when the drive belt is being reused.

Inspecting Drive Belt

- Check for wear and damage.
- Check for missing teeth.
- Check for presence of oil.

Replace in cases where even the slightest defect is found.

Air Compressor Configuration



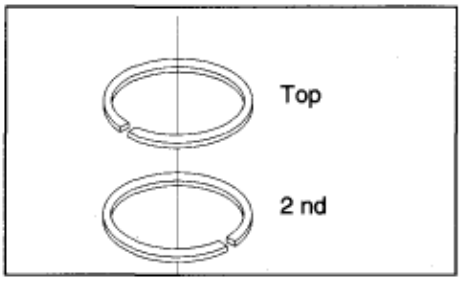
Inspecting Air Compressor

No.	Component	Points to check
①	Piston	• Wear and damage • Check outer diameter of piston • Connecting rod : Confirm smooth operation • Big end bearing : Confirm smooth operation
②	Piston ring	• Measure piston ring end gap
⑤	Bearing	• Rotate by hand and check for excessive play and catching • Replace with new one if defects are found • Be careful not to scratch housing when removing bearing • Apply force to outer race when press fitting bearing
⑥	Oil seal	• Wear and damage • Replace with new one if defects are found
⑩	0-ring	• Scratches and wear
⑪	Collar	• Wear and damage
⑫	Crankshaft	• Wear and damage
⑬	Cylinder	• Sliding surface of piston for scratches • Correct or replace if problems are detected
㉑	Reed valve	• Wear and damage • Reed valve clearance: 0.2 mm (0.008 in) or less • Correct or replace if problems are detected • Reed valve stopper •°--Wear and damage °- Valve stopper height: 2 mm (0.08 in) -°Correct or replace if problems are detected
㉕	Air filter	• Confirm whether dirty or clogged • Replace with new one if dirty

Assembling Piston

Assemble the following components.

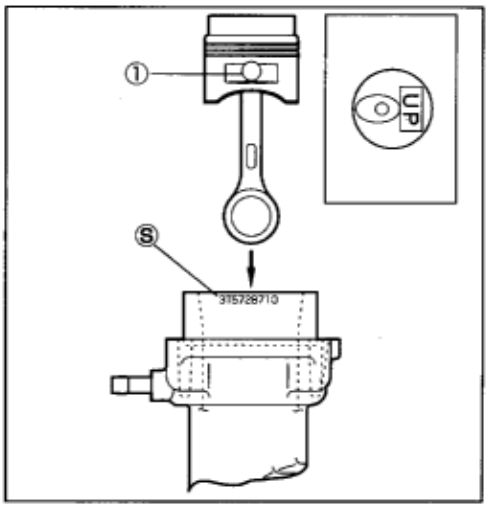
- Piston rings



Assembling Compressor

①Using the piston slider, insert the piston into the cylinder.

Special Tool	① Piston slider
	3T5-72871 -o



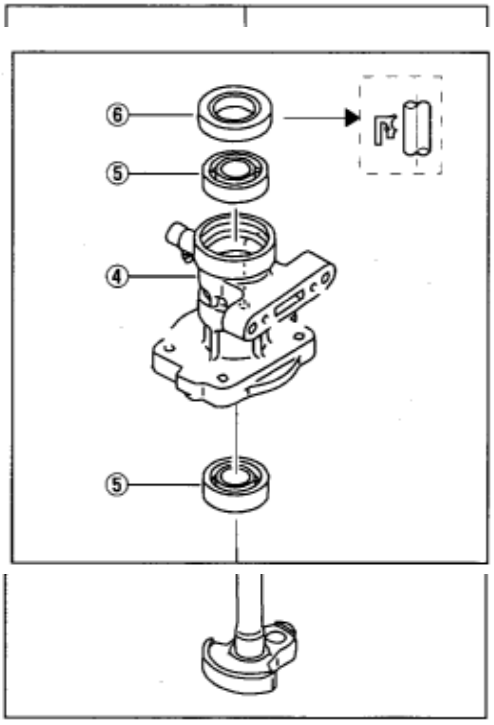
- Prior to inserting piston, apply heat-resistant grease LOR #101 and genuine engine oil mixed at a 1:3 ratio and apply to:
- Outer circumference of piston
- Inside surface of piston slider
- Cylinder wall
- Insert piston with the UP marking at the top.

Assemble the following components.

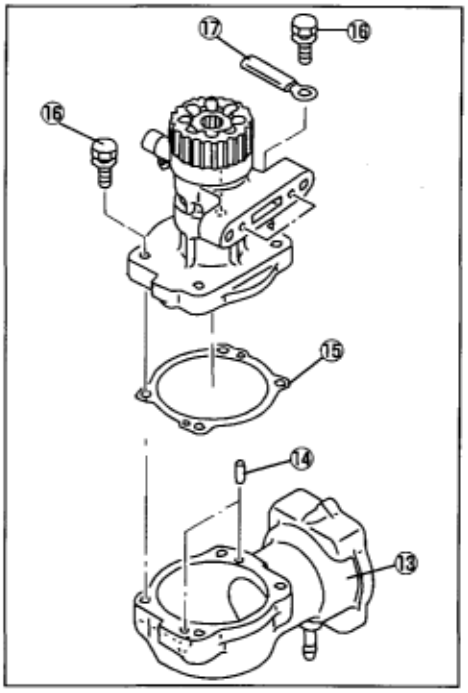
- Nut torque : 44-49N-m(4.5-5.Okg-m) [32-36ft-lb]
- Washer: 10.5-20-3.2
- Pulley
- 0-rings: apply LOR #101
- Bushing
- Oil seal: apply LOR #101
- Bearings: apply genuine engine oil
- Housing
- Crankshaft

Assemble the following components.

- Knock pins at 2 locations
- Gasket >Replace with new one.
- Bolt: type H625 at 4 locations



- Apply genuine engine oil to the big end of the connecting rod.
- Insert the crank pin in the big end of the connecting rod and install by gently moving the crankshaft.



Assemble following components into the ⑬ cylinder.

⑭Knock pins at 2 locations

⑮Gasket >Replace with new one.

⑯Bolt: type H625 at 4 locations

⑰Cramp at 1 location

- Apply genuine engine oil to the big end of the connecting rod.
- Insert the crank pin in the big end of the connecting rod and install by gently moving the crankshaft.

Assembling cylinder head.

Assemble following components.

⑱Bolt: type H630 at 4 locations

⑲Cylinder head

⑳Compressor head gasket >Replace with new one.

㉑Reed valve assembly

㉒Valve seat gasket >Replace with new one.

- Take care not to confuse the top and bottom or front and rear of the reed valve assembly.
- Take care not to confuse the compressor head gasket and valve seat gasket.
- Be sure to completely degrease the mating surfaces of the reed valve sheet and gasket.

⑱ Torque 7.8—9.8 N-m (0.8— 1.0 kg-m) [5.8 – 7.2 ft-lb]

Attach following components to the head ⑲.

㉓ Metal washer

㉔ Hose joint adaptor

㉕ Air filter

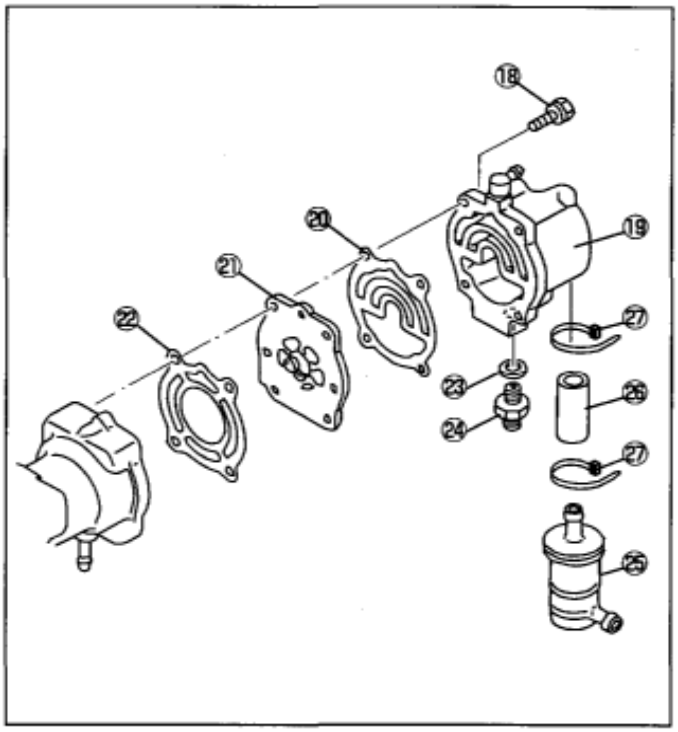
㉖ Hose

㉗ Lead wire band: 2 locations

㉕ Align the air filter intake in the direct figure.

㉔ Apply Thread Lock to the hose joint

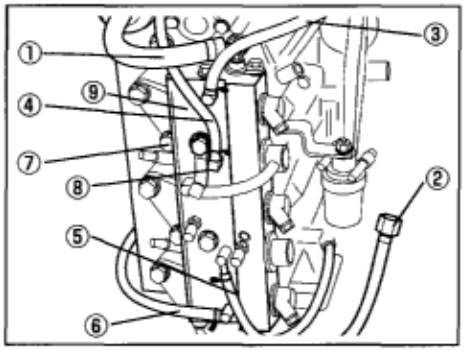
㉔ Torque 14—16 N-m (1.4—1.6kg-m) [10— l2 ft-lb]



Disassembling Air Rail

Remove the following components.

①Fuel hose assembly and nipples



Disassemble and pull out the stopper plate.

②Air hose assembly

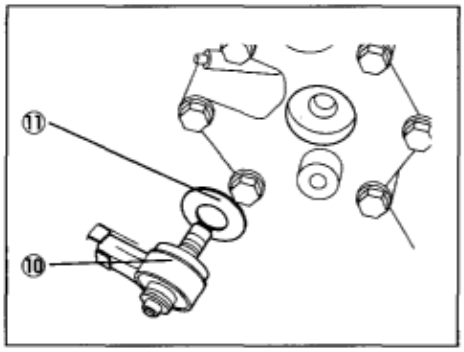
Disconnect the hose joint on the compressor side.

③Cooling water outlet hose

④Fuel return hose

⑤Air discharge hose

⑥Cooling water inlet hose



Remove the following components.

⑦Bolt: type H865 at 2 locations

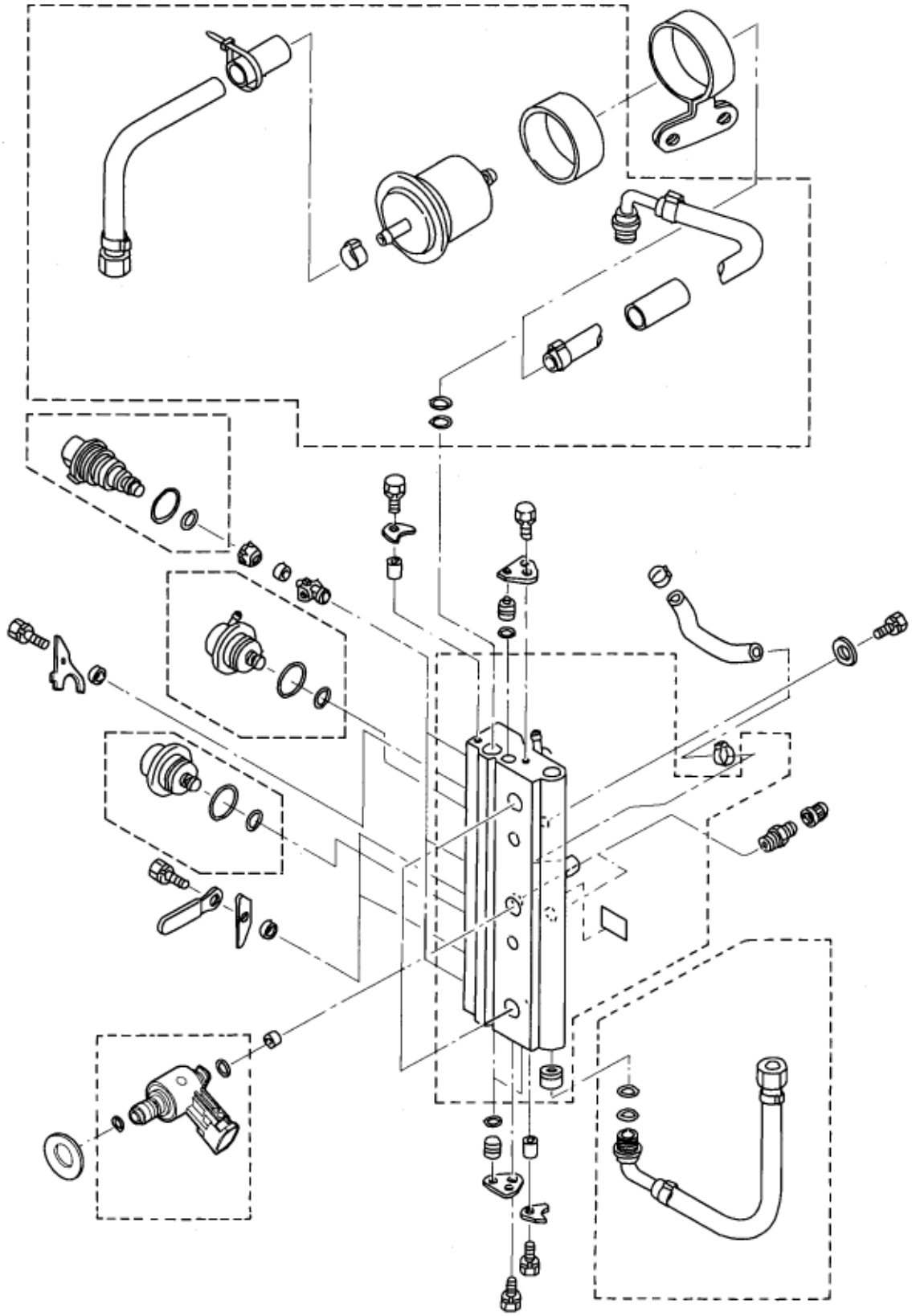
⑧Clamp

⑨Air rail assembly

⑩Air injector: at 3 locations

⑪Air injector set piece: at 3 locations

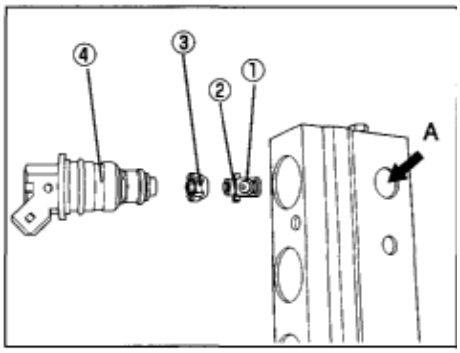
Air Rail Assembly Configuration



Inspecting Air Rail

No.	Components	Points to check
1	Air injector	• Wear, deterioration and damage on 0-rings and seal rings. Replace with new ones if problems are detected. • Remove any carbon buildup on tip using wire brush. • Refer to chapter 6 for electrical system inspection.
2	Set piece for air injector	• Wear, warpage and damage.
3	Fuel injector	• Wear, deterioration and damage on 0-rings. Replace with new ones if problems are detected. • Refer to chapter 6 for electrical system inspection.
4	Fuel regulator	• Wear, deterioration and damage on 0-rings. Replace with new ones if problems are detected. • Clogged regulator strainer. Clean if foreign matter is present. • Wear, deterioration and damage on pressure hose. • Replace with new one if problems are detected.
5	Air regulator	• Wear, deterioration and damage on 0-rings. Replace with new ones if problems are detected. • Clogged regulator strainer. • Clean if foreign matter is present.
6	Valve core (part of valve assembly)	• Wear, deterioration and damage on rubber seal. • Replace with new ones if problems are detected.
7	Plug	• Wear, deterioration and damage on 0-rings. Replace with new ones if problems are detected.
8	Air hose assembly	• Wear and deterioration on hoses and 0-rings. Replace with new ones if problems are detected.
9	Orifice (press fit to air rail)	• Foreign matter and clogging. • Clean if foreign matter is present.

Assembling Air Rail



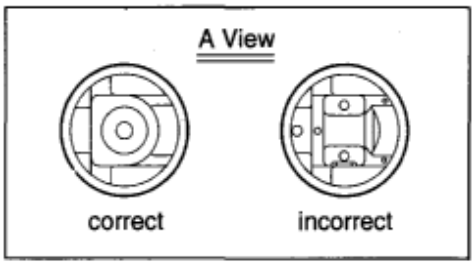
• Apply genuine engine oil to the 0-rings.

Assemble the following components.

①Insert

②Compression seal

- Take care to install with insert ~ facing in the proper direction as shown in View A to the right.



③Adapter

④Fuel injector

- Be sure to use the special tool when installing the 0 rings in the fuel injector.

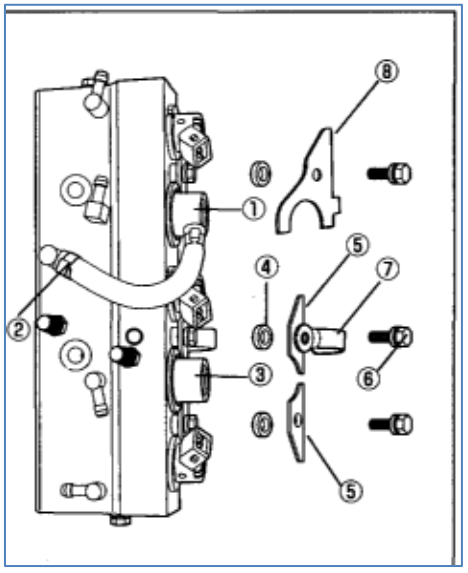
Special tool	0-ring Setting Tool*
	3T5-72863-0

*: Refer to Section 2-5 in chapter.

Assemble the following components.

①Fuel regulator

②Hose clamp >Replace with new one.



Special tool	Crimping pliers*
	3T5-72864-0

*: Refer to Chapter 2-5 in chapter.

③Air regulator

④Collar

⑤ Plate

⑥ Bolt

⑦Clamp

⑧Holding plate

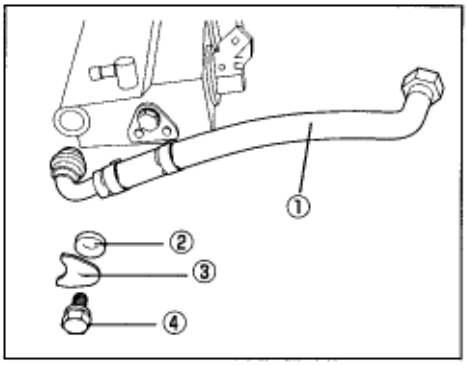
Assemble—components

①Air hose assembly

②Collar

③Nipple plate

④ Bolt



Installing Hoses (See figure)

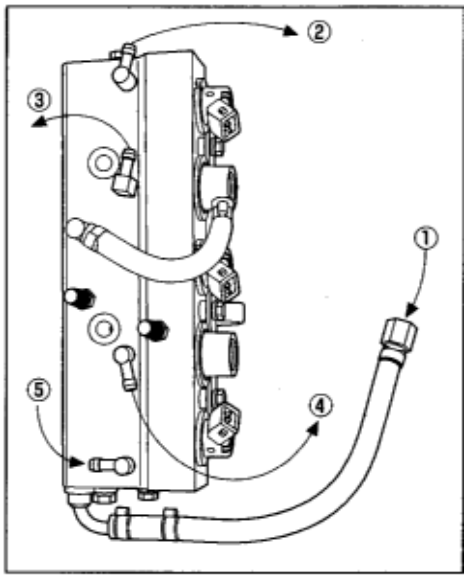
① From air compressor (air)

②To air compressor (cooling water)

③To FFP (fuel)

④To cylinder (air)

⑤From exhaust cover (cooling water)



3. Fuel System

Disassembling Fuel Hose Assembly

Remove the following components.

①Fuel hose assembly

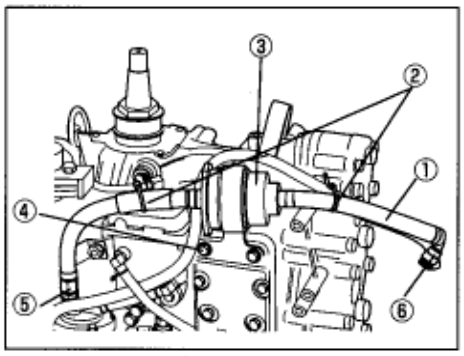
②Lead wire band: at 2 locations

③High-pressure fuel filter

④Bolts: at 2 locations

⑤Connections to FFP

⑥Connections to air rail



Hold a cloth in place to absorb spilling fuel when removing components ⑤ and ⑥.

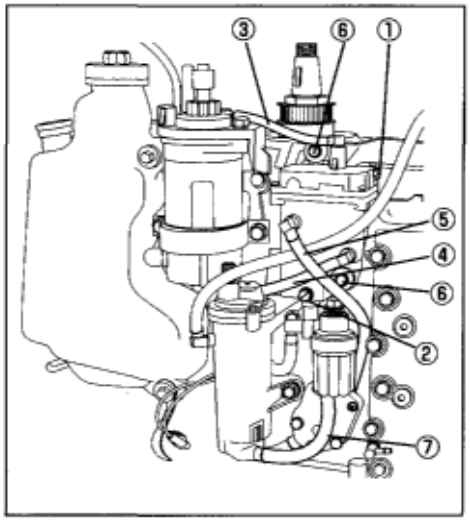
Assembling Fuel and Air Assembly

Assemble in the reverse order of disassembly.

- Bolt: type H630 at 2 locations

Torque: 7.8 to 9.8 N-m: 0.8 to 1.0 kg-m: 5.8 to 7.2 lb-ft

Disassembling Vapor Separator



Drain the fuel from the vapor separator using the following procedures.

①Loosen the air vent screw.

②Loosen the drain screw.

Hold a cloth in place to absorb spilling fuel when loosening ②.

Detach the following hoses.

③Vapor discharge hose

④Vapor return hose

⑤Fuel inlet hose

Hold a cloth in place to absorb spilling fuel when detaching hose ④.

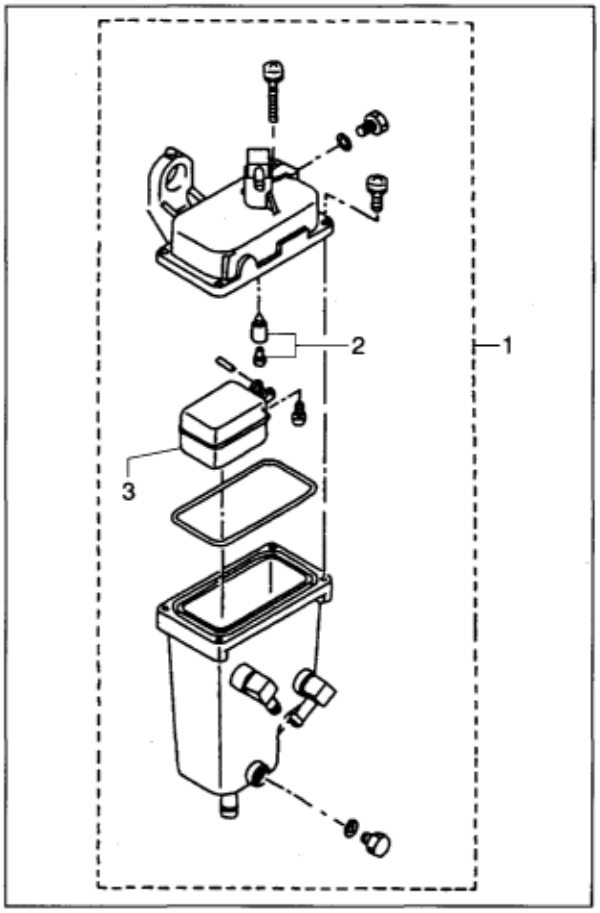
Remove the following components.

⑥ Bolt: type H630 at 2 locations

⑦Fuel outlet hose

Hold a container in place to catch spilling fuelwhen removing hose ⑦

Vapor Separator Configuration



Inspecting Vapor Separator

No.	Components	Points to check
1	0-rings	• Wear, deterioration and damage.
2	Float valve	• Wear, deterioration and damage.
3	Float	• Presence of cracks. • Contamination by fuel.

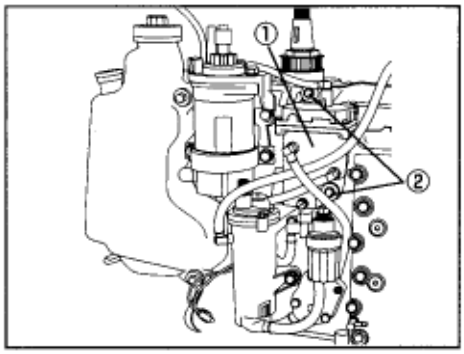
Assembling Vapor Separator

Assemble in the reverse order of disassembly.

①Air vent screw Torque: 0.98 N-m: 0.1 kg-m: 0.7 lb-ft
②Drain screw Torque: 1.4 N-m: 0.14 kg-m: 1.0 lb-ft

Assembling Vapor Separator assembly

Assemble in the reverse order of disassembly.



①Vapor separator assembly

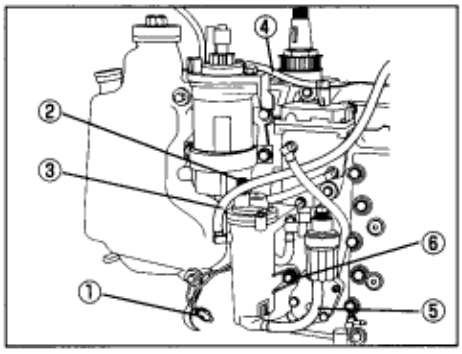
②Bolt: type H630 at 2 locations

- Washers: at 4 locations
- Collars: at 2 locations
- Rubber mounts: at 2 locations

② Torque: 4.6 to 6.3 N-m: 0.47 to 0.64 kg-m: 3.4 to 4.6 lb-ft

Disassembling FFP Assembly *

***FFP:** abbreviation for fuel-feed pump.



Remove the following components.

①FFP connector

②Hose joint

③Fuel return hose

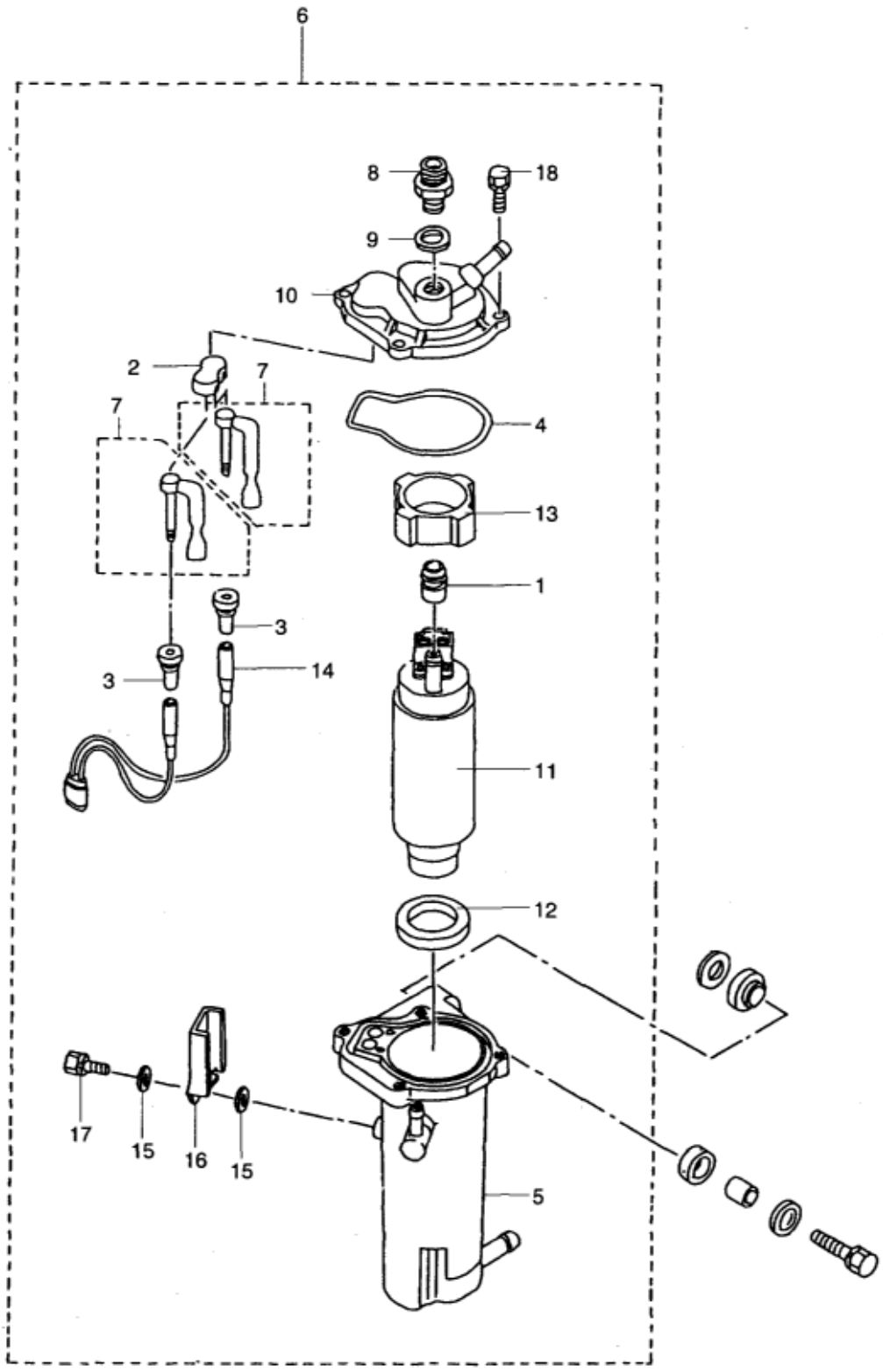
④Vapor return hose

⑤Fuel hose

⑥Bolt: type H630 at 2 locations

Hold a cloth in place to absorb spilling fuel when detaching the hoses.

Fuel Feed Pump (FFP) Configuration



Inspecting FFP

No.	Components	Points to check
1	Pipe grommet	• Wear, deterioration and damage. Replace if defects are detected.
2	Upper cable terminal grommet	
3	Cable terminal grommet	
4	0-rings	
5	FFP Case	• Clogging by foreign matter and water.
6	FFP assembly	• Dirt and foreign matter on lower intake port. • Cracks and damage on upper and lower plastic sections.
7	Cable terminal assembly (+) (-)	• Damage on flat terminal and connector terminal. • Damage on wiring. • Scratches or bending on terminals. • Replace if defects are detected.

Assembling Fuel Feed Pump (FFP)

Assemble the following components.

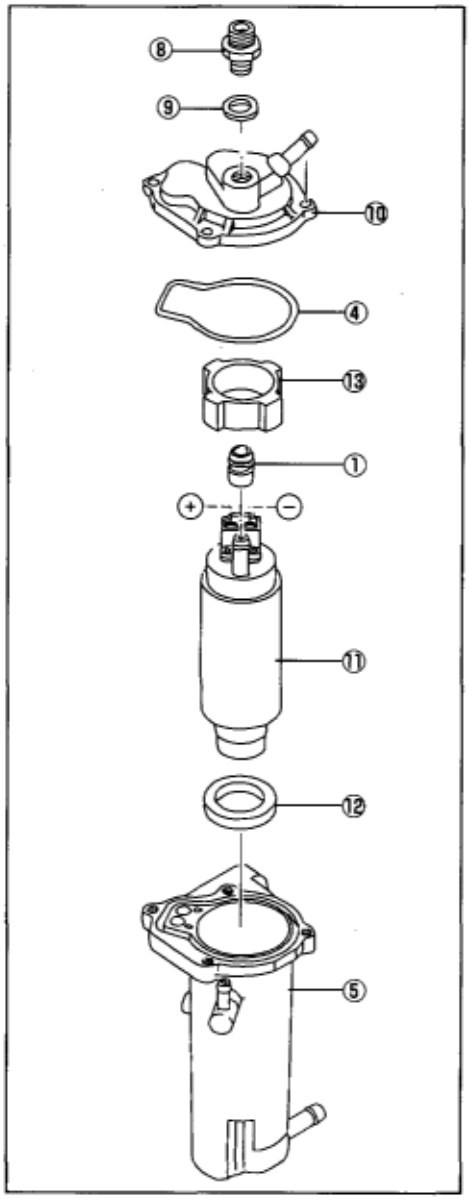
⑧ Hose joint adapter

Torque: 14 to 16 N-m: 1.4 to 1.6 kg-m: 10 to 12 lb-ft
Adhesive to apply after degreasing thread area: Three Bond 1342

⑨ Metal washers

Always replace after disassembly.

⑩Uppercase



Assemble the following components.

①Pipe grommet

⑪FFP

⑫Lower grommet

Grease to apply	① and ⑫ Genuie engine oil

⑤FFP case

⑩Uppercase

The position for ⑤ in relation to ⑪is shown in the figure to the right. Place ⑩ on top and check position.

2.0 to 2.6 lb-ft

Assemble the following components.

⑬Upper grommet

③Cable terminal grommet

Grease to apply	③ and ⑬ Genuine engine oil

⑦Cable terminal (-): black cable

⑦Cable terminal (+): Red cable

Grease to apply	Terminals ⑦ Genuine engine oil

Connect to the flat connector cable terminal by lining up with the mark (+ and/or -)on the FFP.

Assemble the following components

⑭FFP cable

Attach cable to terminal by pressing firmly down from above.

⑮Spacer (washer) : W5

⑯Cable covering

Take care not to pinch cable when closing cover.

⑰Bolt: type H510

Torque: 2.6 to 3.5 N-m: 0.27 to 0.36 kg-m:

Assemble the following components.

② Cable terminal upper grommet

④Seal ring (0-ring)

Grease to apply	②and ④ Genuine engine oil

⑩Uppercase

⑱Bolt: type H518 at 4 locations

Torque: 2.6 to 3.5 N-rn: 0.27 to 0.36 kg-m:2.O to 2.6 lb-ft

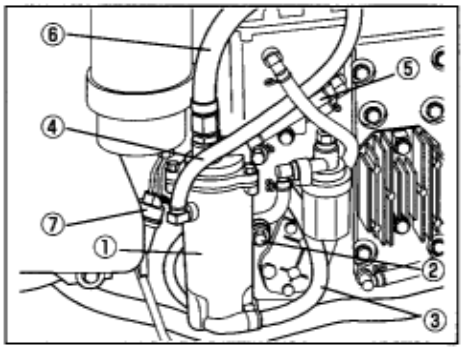
Installing FFP Assembly on Cylinder

Install the following components.

①FFP assembly

② Bolt: type H630 at 2 locations

- Washer
- Rubber mounts
- Collars



Torque: 4.6 to 6.3 N-rn: 0.47 to 0.64 kg-rn: 3.4 to 4.6 lb-ft

③Fuel hose

④Fuel return hose

⑤Vapor return hose

Install hose and apply clip.

⑥High-pressure fuel hose

Torque: l4to 16 N-rn: 1.4 to 1.6 kg-rn: lOto 12 lb-ft

⑦FFP cable connector (cable assembly)

Secure the FFP cable connector to the cylinderusing the clamp.

4) **Oil Pump**

Disassembling Oil Pump and Oil Tank

Disassemble the following components.

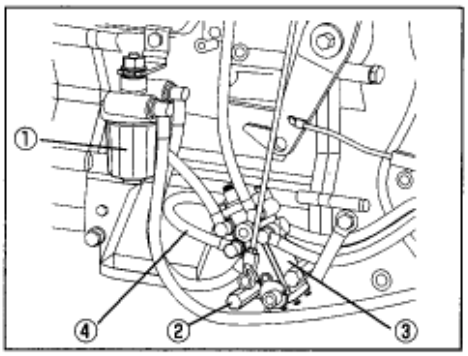
① Oil filter

②Oil pump bolt

③Oil pump

④Oil pipe :4

Remove by pulling the pipes (4) out from oil pump.

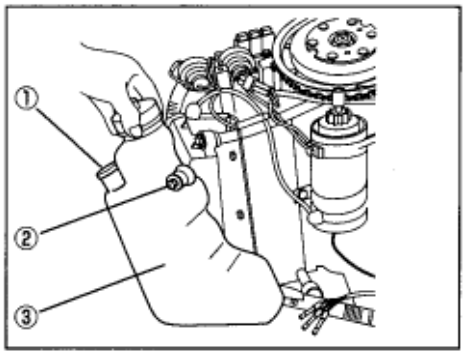


Remove the following components.

①Oil level sensor cable

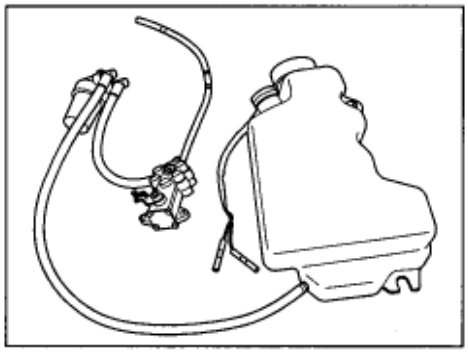
②Bolt: type H630

③Oil tank



The oil tank is insert-mounted at the bottom, socan be removed by simply pulling upward.

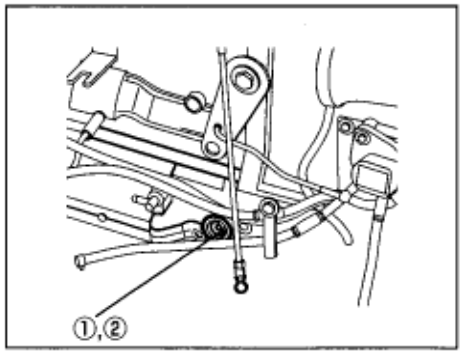
Remove from power unit as shown in the figure tothe right.



Remove the following components.

①Bushing

②Oil pump driven gear



- Rubber mount

Inspect the following components.

①Bushing

②Oil pump driven gear

Check for wear and damage.

Assembling Oil Pump

Assemble the following components

①Bushing

②Oil pump driven gear

Oil to apply	① and ② Genuine engine oil

- Make sure that ®faces right side up.
- Section with large hole faces to the front.

Assembling Oil Pump and Oil Tank

Assemble the following components. (Refer to chapter 1.)

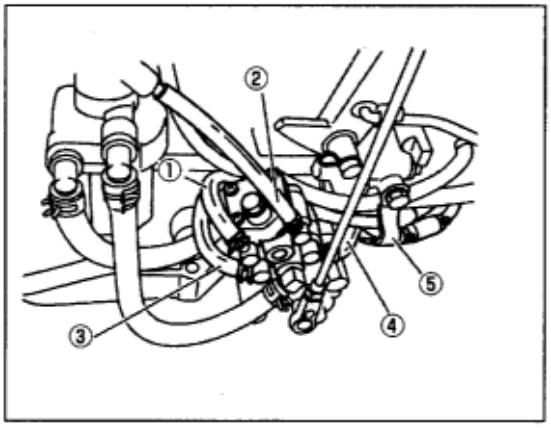
①Oil discharge pipe > #1 air box

②Oil discharge pipe > compressor

③Oil discharge pipe > #2 air box

④Oil discharge pipe > #3 air box

⑤Clamp



- Pass ③and ④through the rear of the oil pump.
- Secure ①,③ and ④ using the clamp⑤.

Make sure that check valve faces in proper direction.

- Install the oil filter on the bracket.

Install the following components.

- Insert the oil tank into the lower rubber mount.
- Connect the oil level sensor.
- Secure the oil pipe using the clamp.

Install the following components.

- Bolt: type H630
- Washer
- Collar

4. Throttle Mechanism

Disassembling Advancer Arm

Disassemble the following components.

① Throttle link rod

②TPS~ link rod

③Oil pump link rod

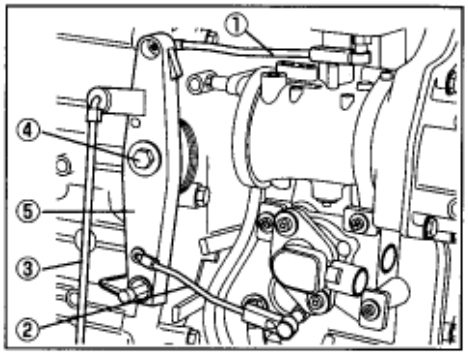
* TPS: abbreviation for throttle position sensor

Prior to removing ①, ②and ③it will be necessary to disconnect the rod snaps from the advancer arm.

Take care not to apply any force to the corresponding arm when disconnecting the ball joint.

④Bolt: type H635, including washers and collar

⑤Advancer arm



Inspect the following components.

①Throttle link rod

②TPS link rod

③Oil pump link rod

• Check ball joint cap for wear and damage. • Check for bent link rods.

Inspect the following components.

- Throttle link rod snap
- TPS link rod snap
- Oil pump link rod snap

Check for wear and damage.

Assembling Advancer Arm

Assemble the following components.

- Advancer arm
- Throttle link rod
- TPS link rod
- Oil pump link rod
- Bolt: type H635
- Washers
- Collar

Install the following components.

- Throttle link ball joint cap
- TPS link ball joint cap
- Oil pump ball joint cap

Install ball joint and cap by hand using a pinching motion.

Take care not to apply force to the TPS lever.

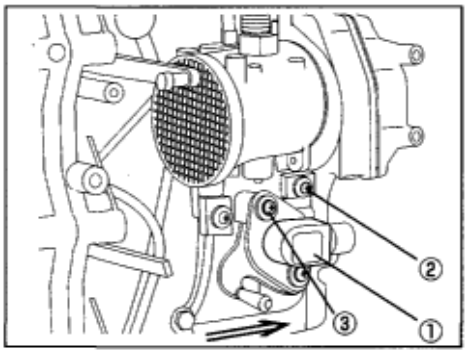
Disassembling TPS

Disassemble the following components.

①TPS assembly

②Screw: type 420 pan head at 3 locations

- Washers
- Collars
- Mount rubber



Remove the following component.

①TPS assembly

• Confirm that arm moves to the direction of arrow mark and returns smoothly. • Check the connectors for damage.

• Never loosen small screw ® that s locked in place using paint. • Doing so will change the 0 point setting, making it unusable.

Refer to chapter 5 when conducting electrical inspections.

Assembling TPS

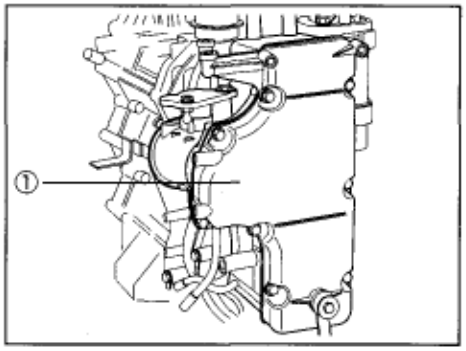
Assemble in the reverse order of disassembly.

Disassembling Air Box and Throttle Body

Disassemble the following components.

- Bolt: type H625 at 8 locations
- Clamp

① Air box cover



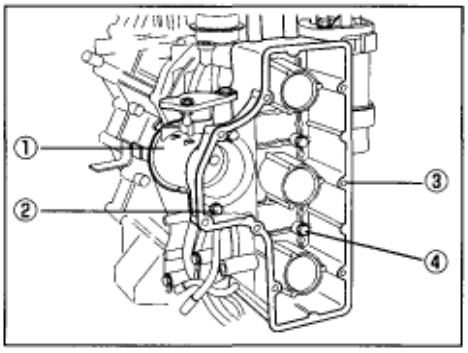
Remove the following components.

②Bolt: type H625 at 2 locations

①Throttle body assembly

④ Bolt: type H625 at 12 locations

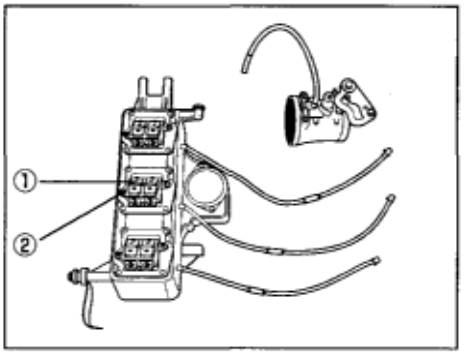
③ Air box



Remove the following components.

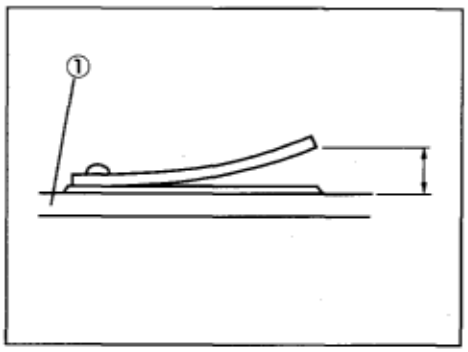
② Screws: type 516 pan head at six locations

①Reed valve assembly



Inspect the following component.

①Reed valve assembly

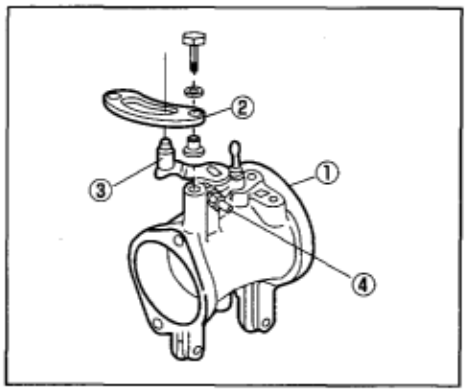


Valve stopper height: 9.3 to 9.5 mm: 0.366 to 0.374 in

Check whether valve closes properly, is worn or damaged.

Inspect the following component.

①Throttle body



- Check throttle cam ②for wear.
- Check cam roller ③for wear.
- Confirm that ②and ③operate smoothly.

Do not touch adjuster screw ④.

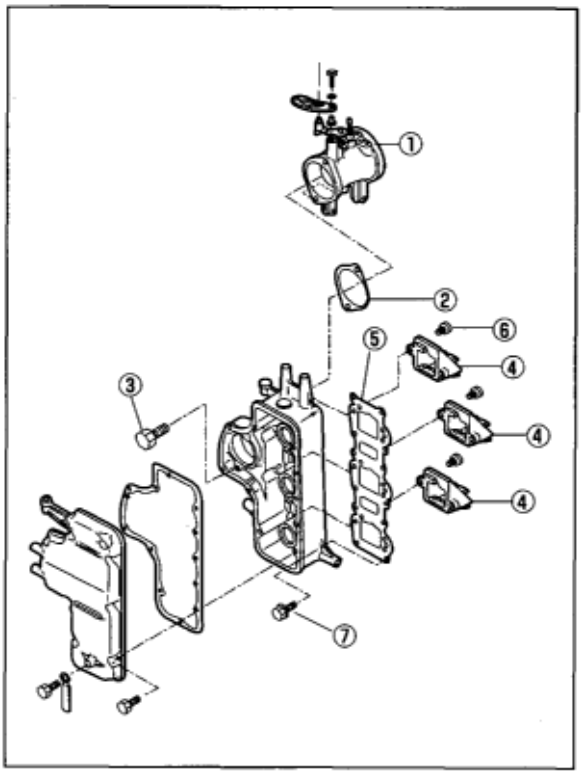
Assembling Air Box

Assemble the Following Components.

①Throttle body assembly

②Gasket> Replace with new one.

③Bolts H625: at 2 locations(apply Three Bond #1342)



Grease to apply	Interacting surfaces of the throttle cam and roller
	OBM Grease

④Reed valve assembly

⑤Gasket >j Replace with new one.

⑥Screws: at 6 locations (apply There Bond #1342)

Assembling Air Box and Throttle Body

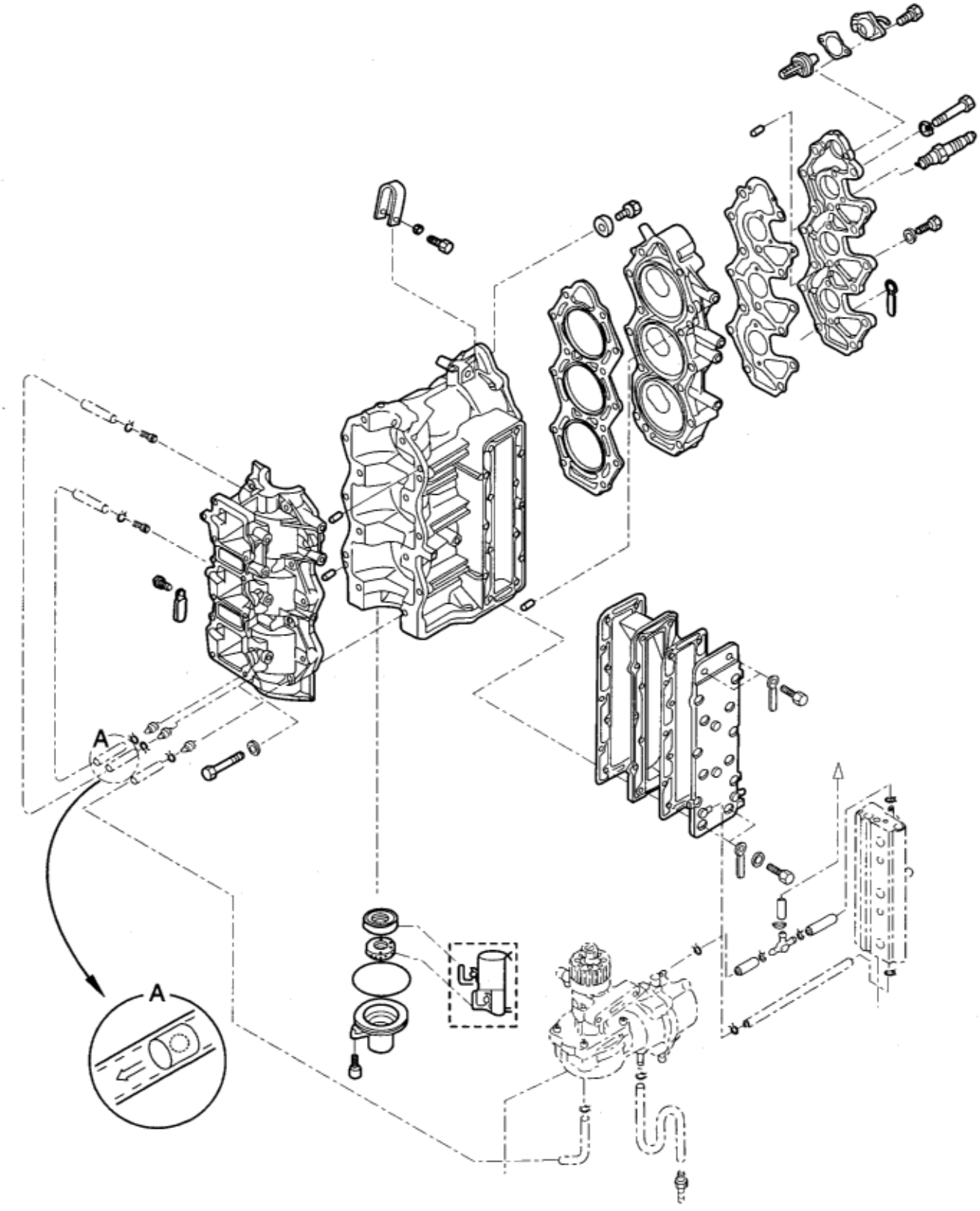
Assemble in the reverse order of disassembly.

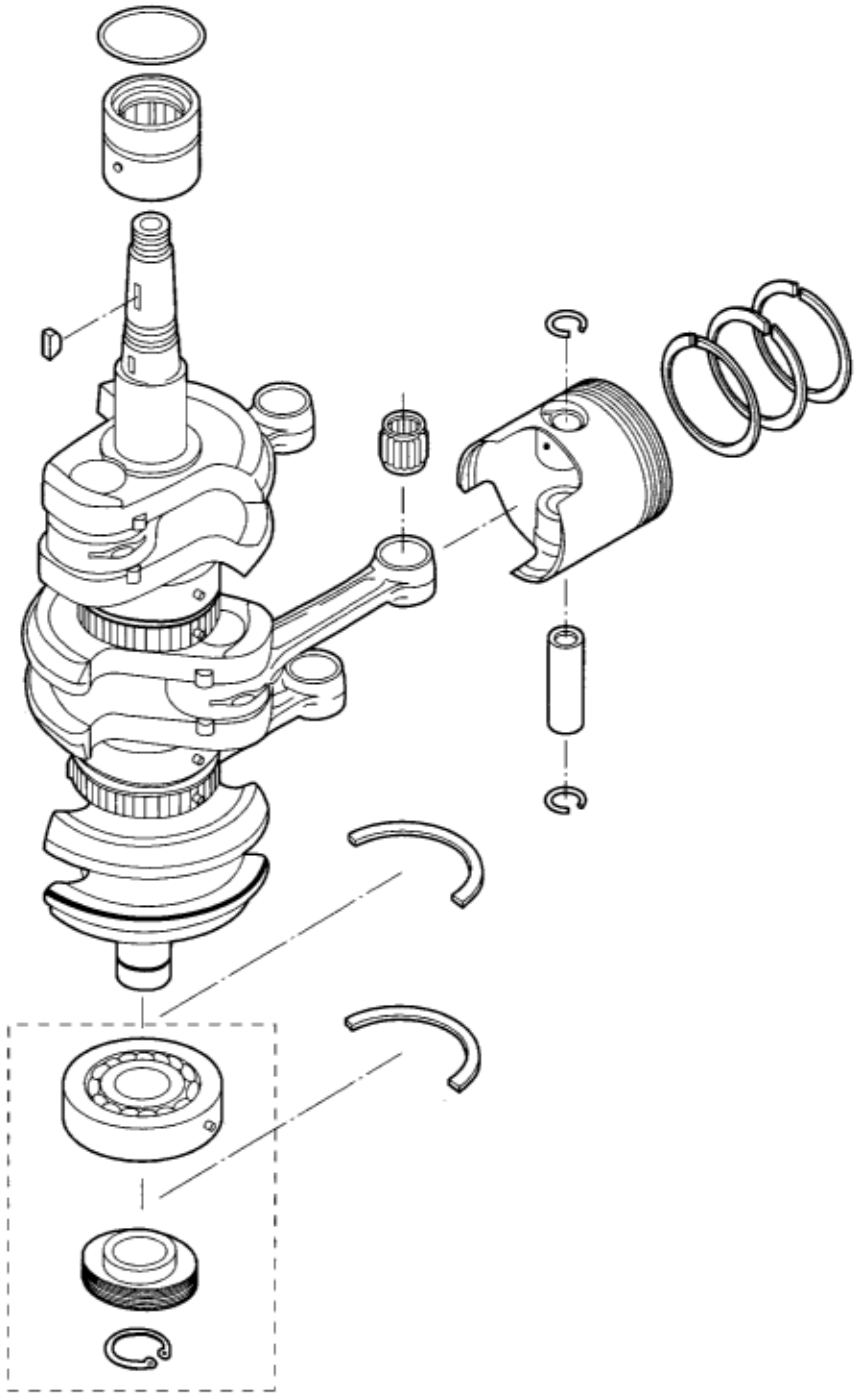
⑦Bolt: type H625 at 12 locations>

Replace with new one or, if reuse current bolts, apply Three Bond #1

5. Disassembling Engine Block

Cylinder and Crankcase Assembly





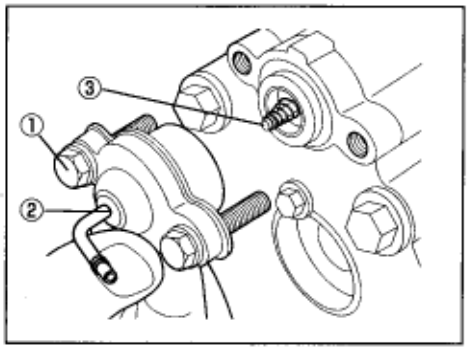
Removing Thermostat

Remove the following components.

①Bolt: type H625 at 2 locations

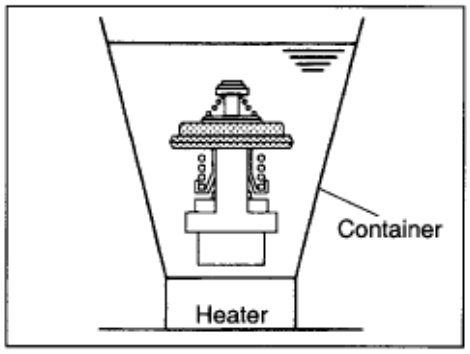
②Thermostat cap

③Thermostat



Inspect the following components.

- Check to see whether foreign matter has entered valve.
- Confirm valve operates within designated temperature range.
- Valve opening temperature : 52°C ± 1.5°C
  126°F ± 3°F
- Valve full open temperature: 65°C ± 1.5°C
  149°F ± 3°F
- Valve full lift height: 3 mm (0.12 in) or more



Disassembling Cylinder Head and Head Cover

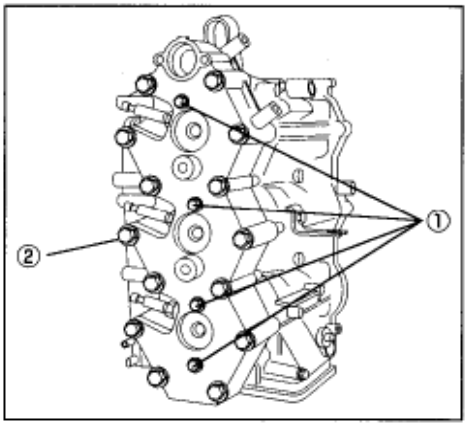
Remove the following components.

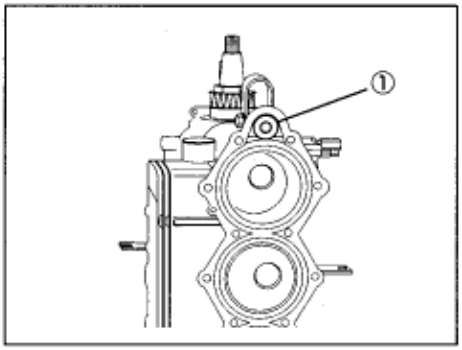
①Bolt: type H625 at 4 locations

Remove the 6 mm bolt first.

②Bolt: type H865 at 14 locations

When removing the 8 mm bolts, loosen in sequence starting from the highest embossed number.





Inspecting Engine Anode

Inspect the following component.

①Engine anode

Replace when excessively worn.

Inspecting Cylinder Head

Inspect the following components.

①Cylinder head

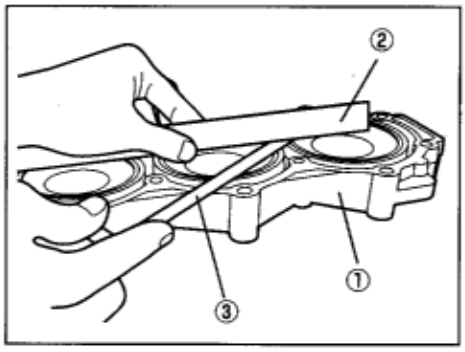
Inspecting:

Check for carbon deposit in combustion chamber.

Check for sediment in water jacket.

Inspecting:

- Use components ② and ③ to measure distortion.
- ②Straight gauge
- ③Thickness gauge
- Maximum limit: 0.03 mm: 0.001 in



Cleaning:

- Clean using a scraper or brush.
- Take care not to scratch any surfaces that are being cleaned.

Adjustment:

- If distortion exceeds limits, repair by polishing the surface plate using #240 to #400sandpaper in a figure eight pattern.
- Once surface is repaired finish using #600 sandpaper.

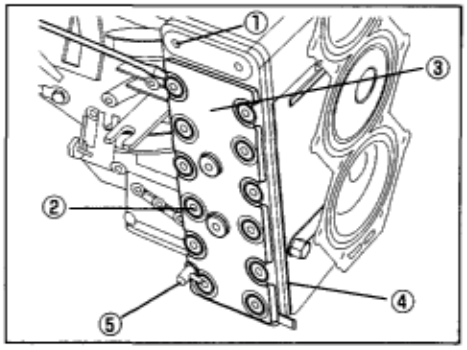
using a plastic hammer.

Disassembling Exhaust Cover

Remove the following components.

①Bolt: type H630 at 2 locations

②Bolt: type H630 at 12 locations



Remove in order starting from the highest embossed number.

③Outer exhaust cover

④Inner exhaust cover

Remove by prying gently with a flathead screwdriver alternately along the 4 grooves on the sides of the cover. Prying too forcefully at only one groove may bend the cover.

Inspecting Exhaust Cover

Inspect the following components.

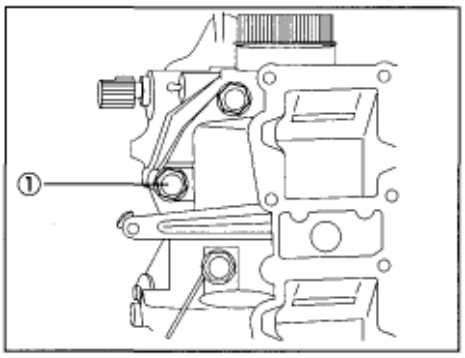
③Outer exhaust cover

④Inner exhaust cover

⑤Cooling water nipple

Inspecting

- Check for scratches and distortion on mating surfaces.
- Check cooling water nipple and other passageways for clogging.



Disassembling Crankcase

Remove the following component.

①Crankcase bolt: type H845 at 14 locations

Remove in order starting from outer ones to inner ones diagonally or circularly.

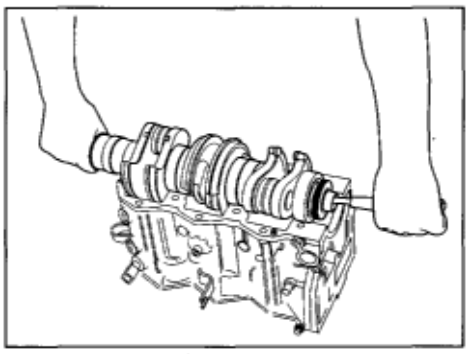
Remove the following components.

- Bolt: type H625 at 2 locations for crankcase head
- Crankcase head
- Crankcase

- Remove by prying gently along the grooves with a flathead screwdriver.
- If the crankshaft is stuck to the crankcase, disengage by tapping lightly

Remove the following component.

Crankshaft assembly

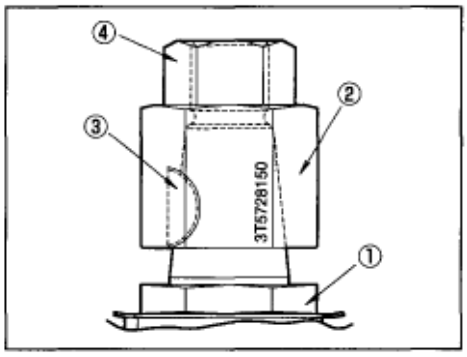


Disassembling Drive Pulley

Remove the following components.

①Pulley nut (36 mm)

Special tool	Crankshaft holder (36mm)
	3T5-72815-0



③Magneto key

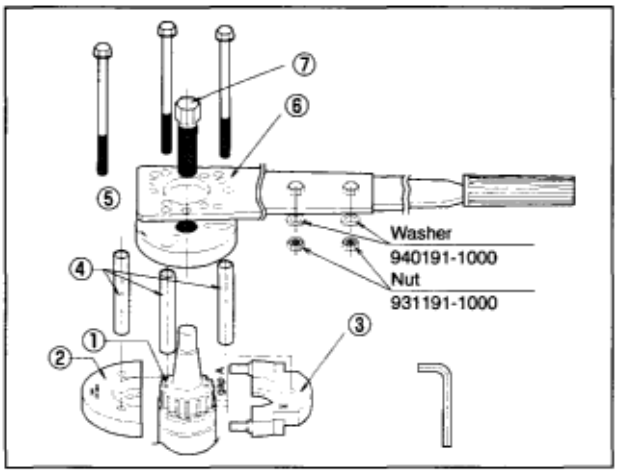
④Magneto nut

- Install the magneto key on the crankshaft holder ②and secure using the magneto nut.
- Using two 36 mm wrenches, use one to secure the crankshaft holder and the other to loosen the pulley nut.
- After sufficiently loosening the pulley nut remove the key; then remove the pulley nut.

Remove the following components.

①Drive pulley

Special tool	Drive pulley puller assembly
	3T5-72890-O



- Install plates ②and ③so that they enclose pulley into the gap A as shown.. Then install collars ④, ⑤and ⑥.
- Apply grease to the tip and the thread area ⑦
- Remove the pulley by tightening the bolt ⑦.(19 mm)

Removing Piston

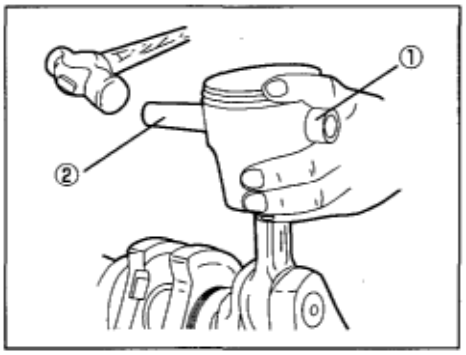
Remove the following components.

- Piston pin clip at 2 locations

Remove both and take care not to scratch the pinhole.

Remove the following component.

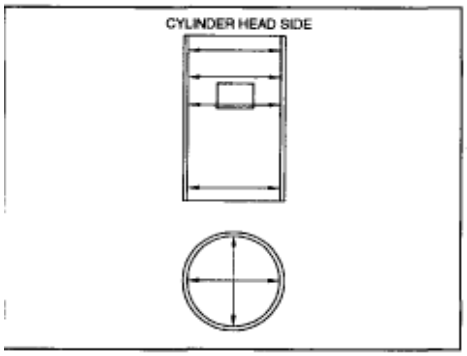
②Piston pin



Special tool	② Piston pin tool
	345-72215-0

• Position ②against piston pin; then holding the opposite side by hand tap lightly on ②with a hammer to remove pin.
• Take care not to apply bending force to the connecting rod when using the hammer.

Inspecting Engine Components I

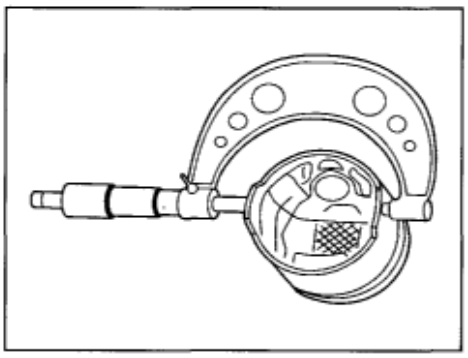


Inspecting Cylinders

- Cylinder bore (using cylinder gauge)

Standard value	Service limit
68.05 mm (2.679 in)	Replace when 68.11 mm (2.682 in) or more

- Measure the area showing the greatest wear.
- Also replace when difference between minimum and maximum cylinder bore is 0.06 mm(0.002 in) or more.

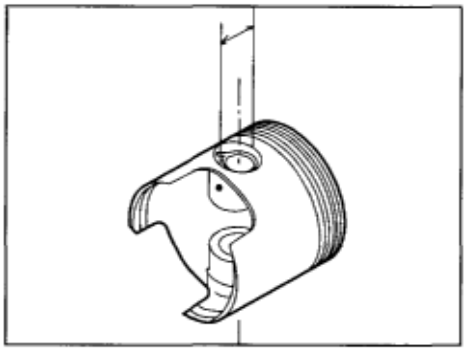


Inspecting Piston

- Outer diameter of piston skirt (using micrometer)

Standard value	Service limit
67.96 mm (2.676 in)	Replace when 67.90 mm (2.673 in) or more

Measure at point 12 mm (0.47 in) from the bottomof the piston skirt.



- Piston clearance (between cylinder and piston)

Standard value	Service limit
0.08 to 0.12 mm (0.003 to 0.005 in)	Replace when 0.21 mm (0.008 in) or more

- Inner diameter of piston pin hole (using cylinder gauge)

Standard value	Service limit
17.00 mm (0.67 in)	Depends on clearance with pin

- Clearance between piston pin and pin hole

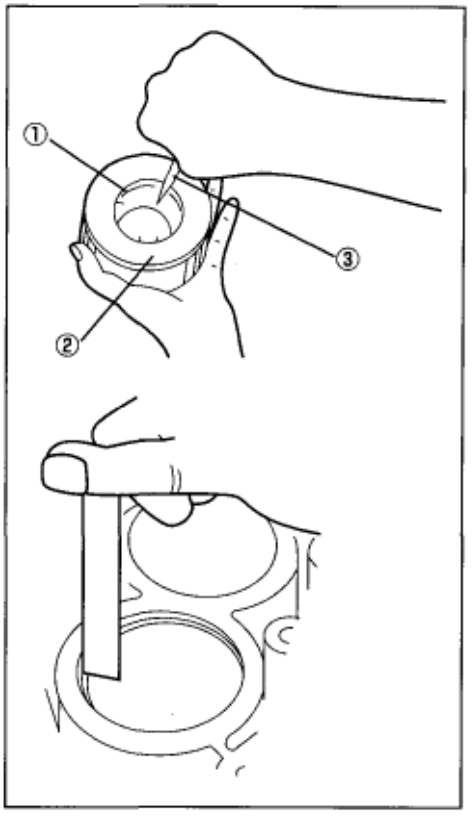
Standard value	Service limit
Tight: 0.003 miii (0.00012 in)	Replace when 0.02 mm (0.0008 in) or more
Loose: 0.007 mm (0.0028 in)	

Inspecting Piston Rings

①Piston ring

②Ring gauge

③Thickness gauge



- Piston ring end gap

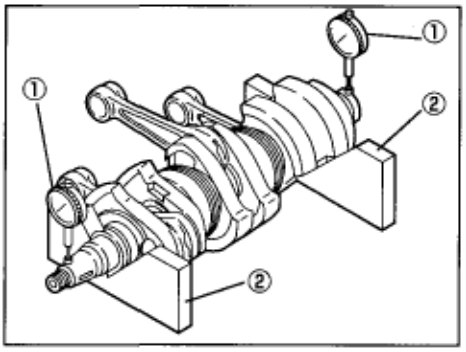
Ring	Standard Value	Service Limit
Top	0.22 to 0.37 mm (0.009 to 0.015 in)	Replace when 0.8 mm (0.032 in) or more
2nd,3rd	0.33 to 0.48mm (0.013 to 0.019 in)	Replace when 0.9 mm (0.035 in) or more

- Pressing the ring on the piston crown, place in ring gauge.
- Use cylinder when ring gauge is not available.

Inspecting Crankshaft

①Dial gauge

②V block

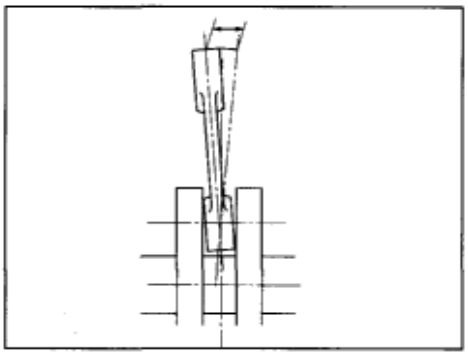


- Crankshaft run-out

Standard Value	Service Limit
Within 0.05 mm (0.002 in)	Replace when 0.05 mm (0.002 in) or more

- Connecting rod deflection

Standard value	Service limit
Within 2 mm (0.08 in)	Replace when 2 mm (0.08 in) or more

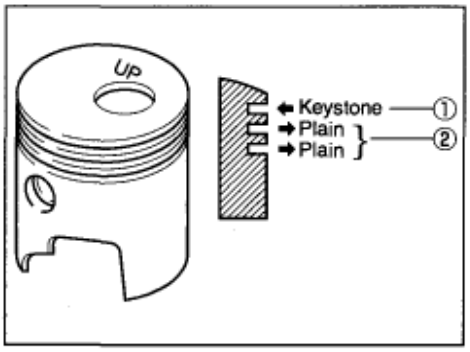


Crankcase Assembling Piston

Assemble the following components.

①Top ring (Keystone ring: iT)

②2nd and 3rd rings (plain rings: stamped 2T)



Special Tool	Piston ring tool
	353-72249-0

- Install starting from the 3rd ring.
- Install with the stamped mark facing upwards.
- Line up piston ring end gap with knock pin.

Assemble the following component.

- Piston pin clip

- Install only on one side first prior to installing piston pin.
- Always use a new piston pin clip.
- The piston pin clip gap should face in the opposite direction of groove.

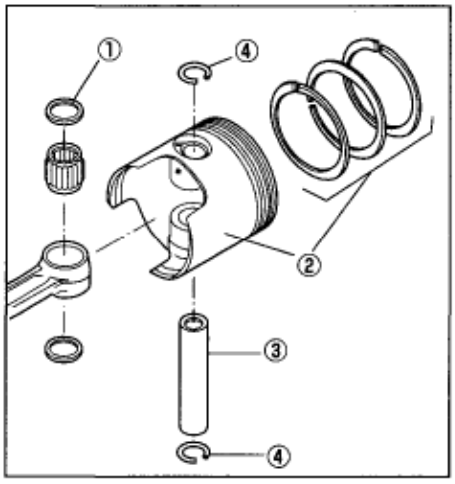
Assemble the following components.

①Small end bearing

②Piston with piston rings

③Piston pin

④Piston pin clip



Special tool	Piston pin tool
	345-72215-0

- Apply engine oil to the pin hole and small end bearing.
- Position piston to connecting rod; then place piston pin tool against pin and tap lightly with a hammer to install. [up]mark of piston must face up(flywheel)side.
- After installation,install the other piston pin clip.

Assembling Short Block

Assemble in reverse order of disassembly.

Apply genuine engine oil to the following parts.

- Big end of connecting rod
- Small end of connecting rod and pin boss oil hole
- Main bearing
- Piston ring and entire circumference of piston
- Entire surface of cylinder bore
- Upper bearing 0-ring

Line up piston ring end gap with knock pin.

Assembling Crankshaft

Degrease the mating surfaces of the crankcase

Assemble the crankshaft and the cylinder using the Following procedures.

Points to Note:

Make sure that all pistons are positioned perpendicularly; the insert piston in perpendicular direction using gentle jiggling motion.
Make sure pistons are not twisted in horizontal direction.

Take the following steps prior to completing assembly of the crankshaft.

- Install thrust plates at 2 locations.
- Line up the bearing knock position.

Insert in groove on mating surface.

- Lining up position of upper bearing

Line up of the knock holes on the upper bearing with the knock pins on the journal of the cylinder.

Gently move the upper bearing to confirm it Is correctly positioned on the knock pins.

Assembling Crankcase

Degrease the mating surface of the crankcase.

Caution:

Insufficient degreasing will render sealant less effective,resulting in oil leakage.

Apply sealant evenly 0ver the mating surface on the cylinder
Sealant: Loctite #518

Apply evenly inside the bolt holes so that there are no bare patches.Be careful not to apply too much.

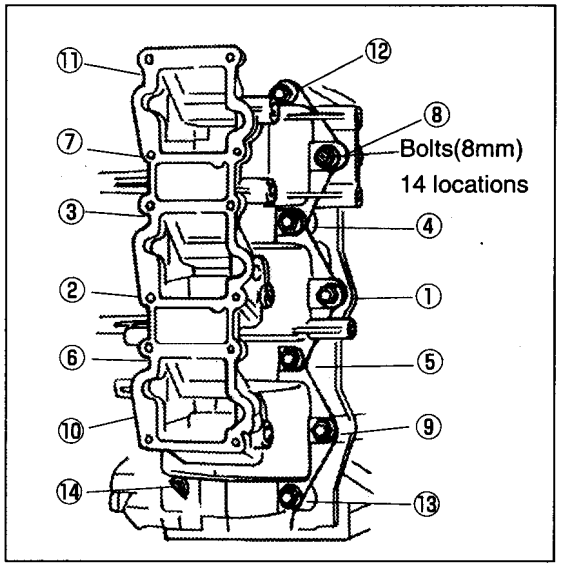
Tap in knock pins at 2 locations on the cylinder; then install crankcase.

Install by tapping with a plastic hammer to ensure that there is an even clearance across the mating face.

Install the crank case bolts.

Tighten bolts in the proper order.

M8partialtorque:	12to15N-m:1.2to1.5kg-m	8
:	9to11lb-ft	
M8fulltorque :	24to26N-m:2.4to2.6kg-m	
:	17to19Lb-ft	



Assembling Cylinder Head

Degrease all mating surfaces on cylinder, cylinder head and head cover.

Install the following components.

- Anode
- Knock pins at 2 locations
- Head gasket >Replace with new one.
- Cylinder Head
- Head cover Gasket >Replace with new one.
- Head cover
- Washer
- Bolt

Tighten in two stages in the order of the embossed numbers.	
M6 partial torque:	2.0to2.9N-m:0.2to0.3kg-m :1.5to2.1lb-ft
M6fulltorque	:4.6to6.3N-m:0.4to0.6kg-m :2.9to4.3lb-ft
M8 partial torque:	12 to 15N-m:1.2to1.5kg-m :8.7to10.9lb-ft
M8fulltorque	:29to34N-m: 3.0to3.5kg-m :22to25lb-ft

Insure proper installation of the check valve inside the hose.

The following components.

- Thermostat
- Thermostat cap gasket ➡ Replace with new one.
- Thermostat cap
- Bolt :at 2 locations

Torque :4.6to6.3N-m:0.47 to0.64kg-m :3.4to4.6lb-ft

Caution:

Be sure to tighten M6 bolts only after tightening the M8 bolts on the head cover .Never tighten the M6 bolts first.

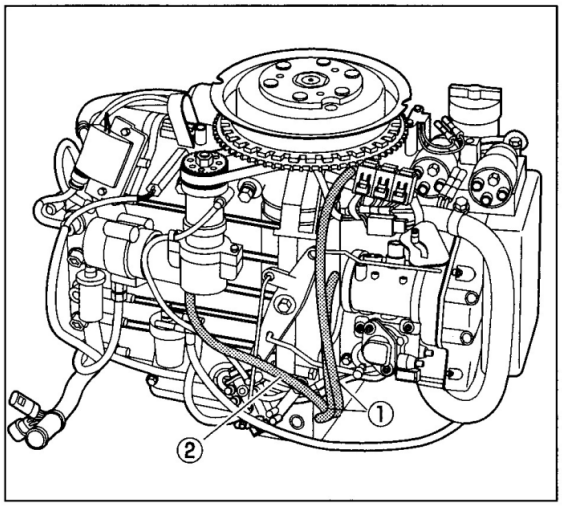
Assembling Exhaust Cover

Clean away any dirt or foreign matter on the mating surfaces of the cylinder and inner and outer exhaust covers; then degrease.

Assemble the following components.

- Exhaust cover gasket > Replace with new one
- Inner exhaust cover
- Exhaust cover gasket> Replace with new one
- Outer exhaust cover
- Fuel filter band
- Washers: at 14 locations
- Bolt: typeH625 at 14 locations

Tighten in the order of the embossed numbers.
Partial torque: 3.9to5.9N-m:0.4to 0.6kg-m :2.9to4.3lb-ft
Full torque : 7.8to9.8N-m:0.8to1.0kg-m :5.8to7.2lb-ft



Installing Recirculator Hose

Install the following components.

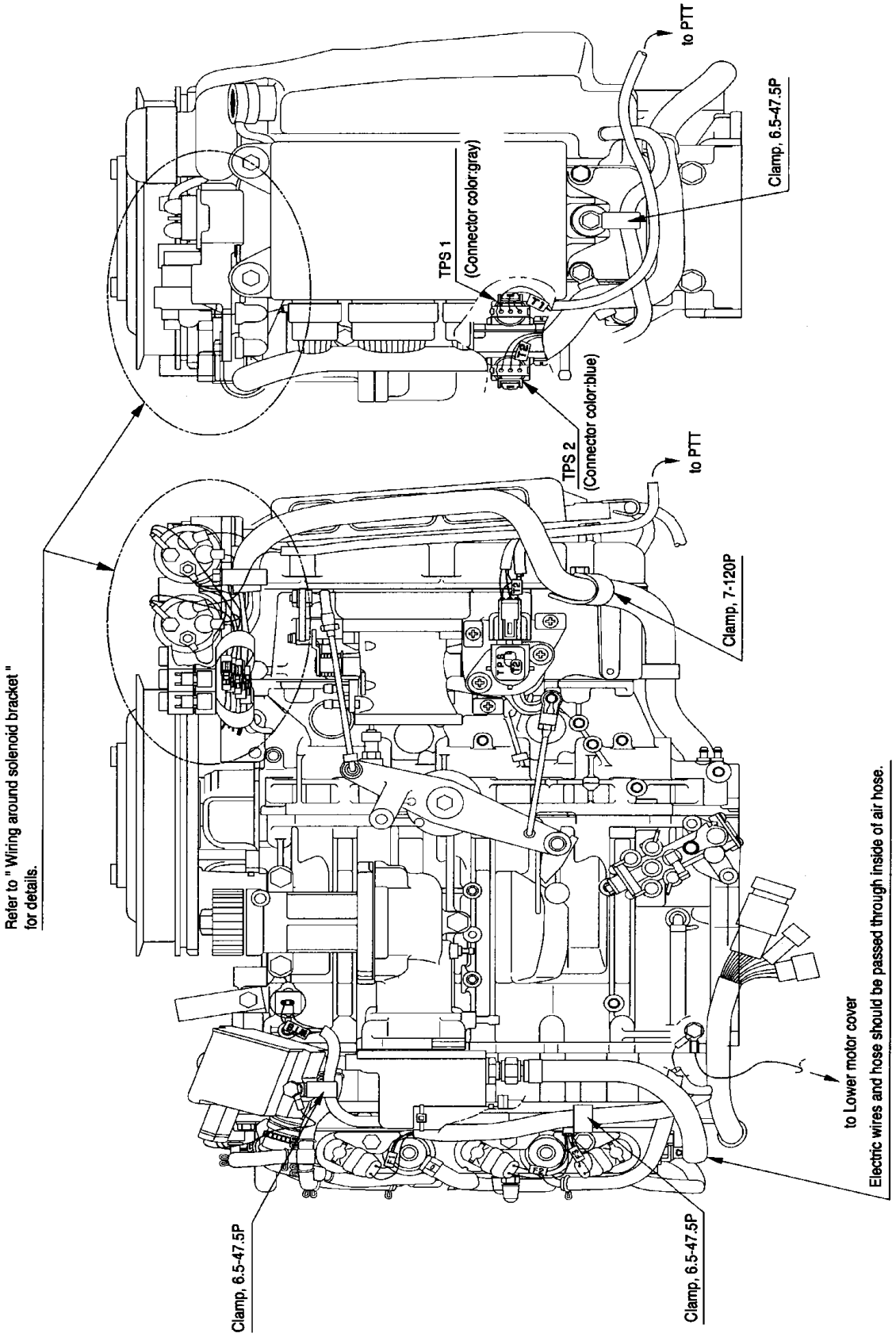
① Lubrication pipe

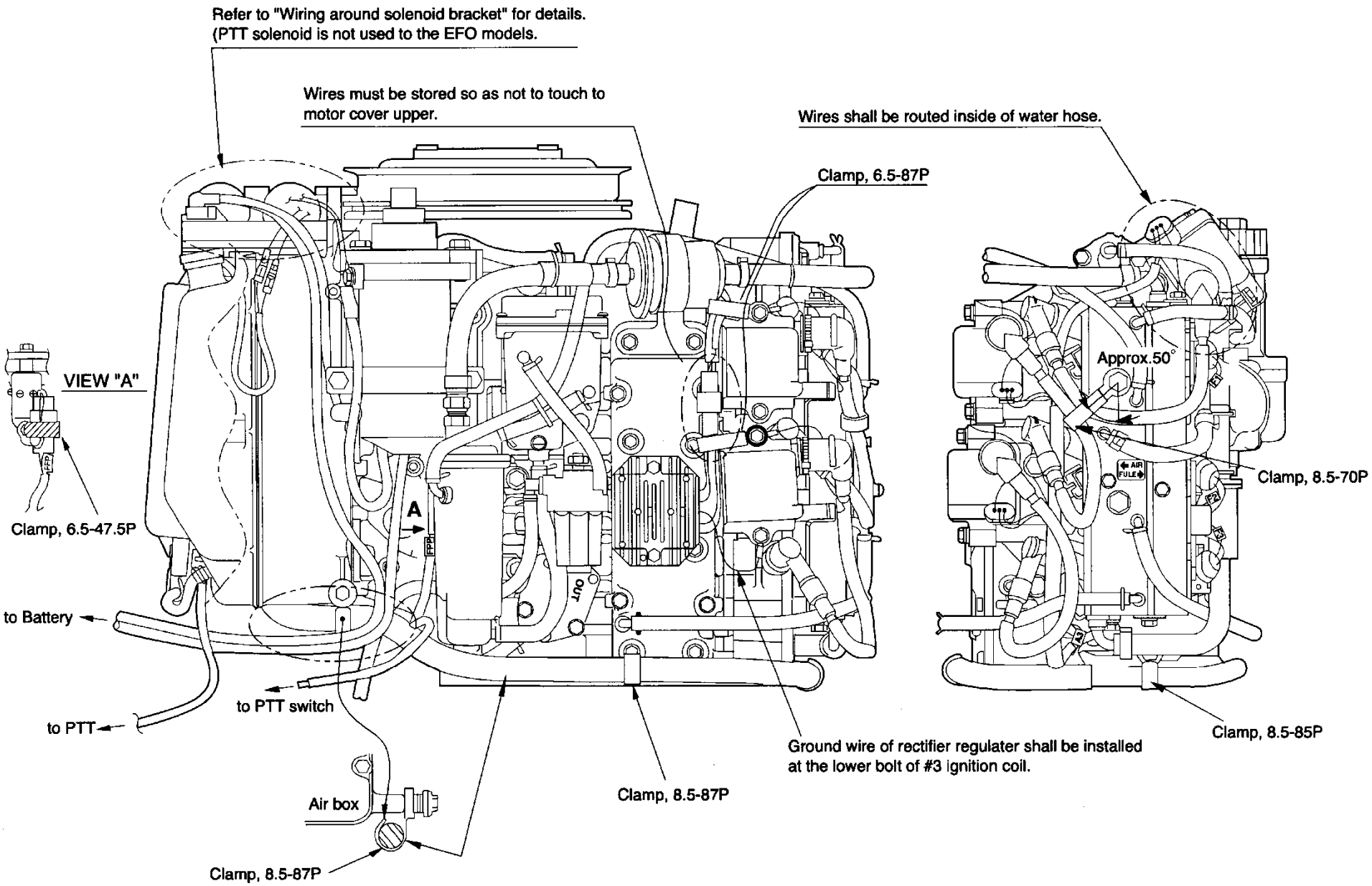
②Oil return pipe from compressor

- Hoseclips:3 sets(6pcs)

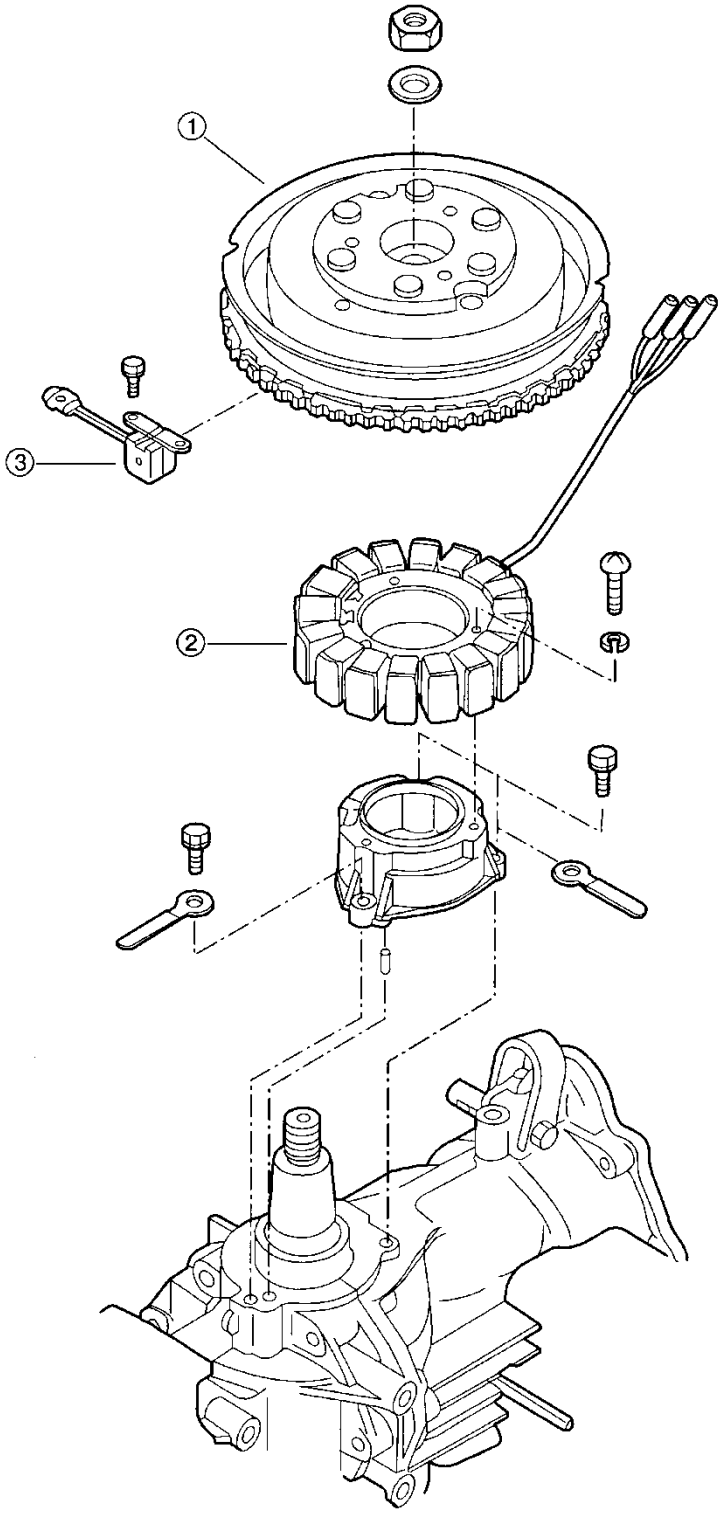
Caution:

1. Wire Routing

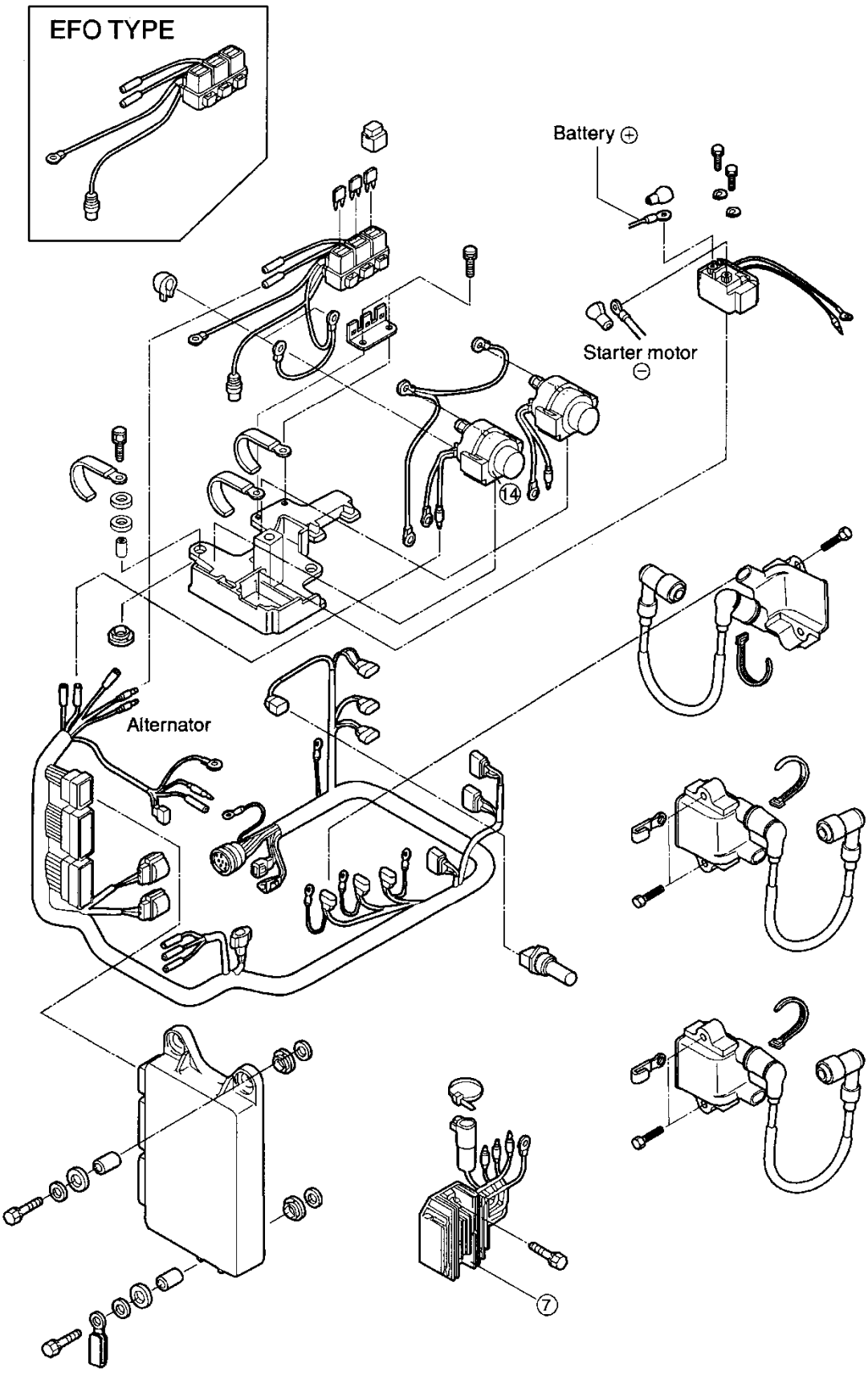



Refer to "Wiring around solenoid bracket" for details.
(PTT solenoid is not used to the EFO models.
Wires must be stored so as not to touch to motor cover upper.
Wires shall be routed inside of water hose.
Clamp, 6.5-87P
VIEW "A"
Clamp, 6.5-47.5P
A
FPP
OUT
to Battery
to PTT
to PTT switch
Air box
Clamp, 8.5-87P
Clamp, 8.5-87P
Ground wire of rectifier regulater shall be installed at the lower bolt of #3 ignition coil.
Approx.50°
AIR
FUEL
Clamp, 8.5-70P
Clamp, 8.5-85P

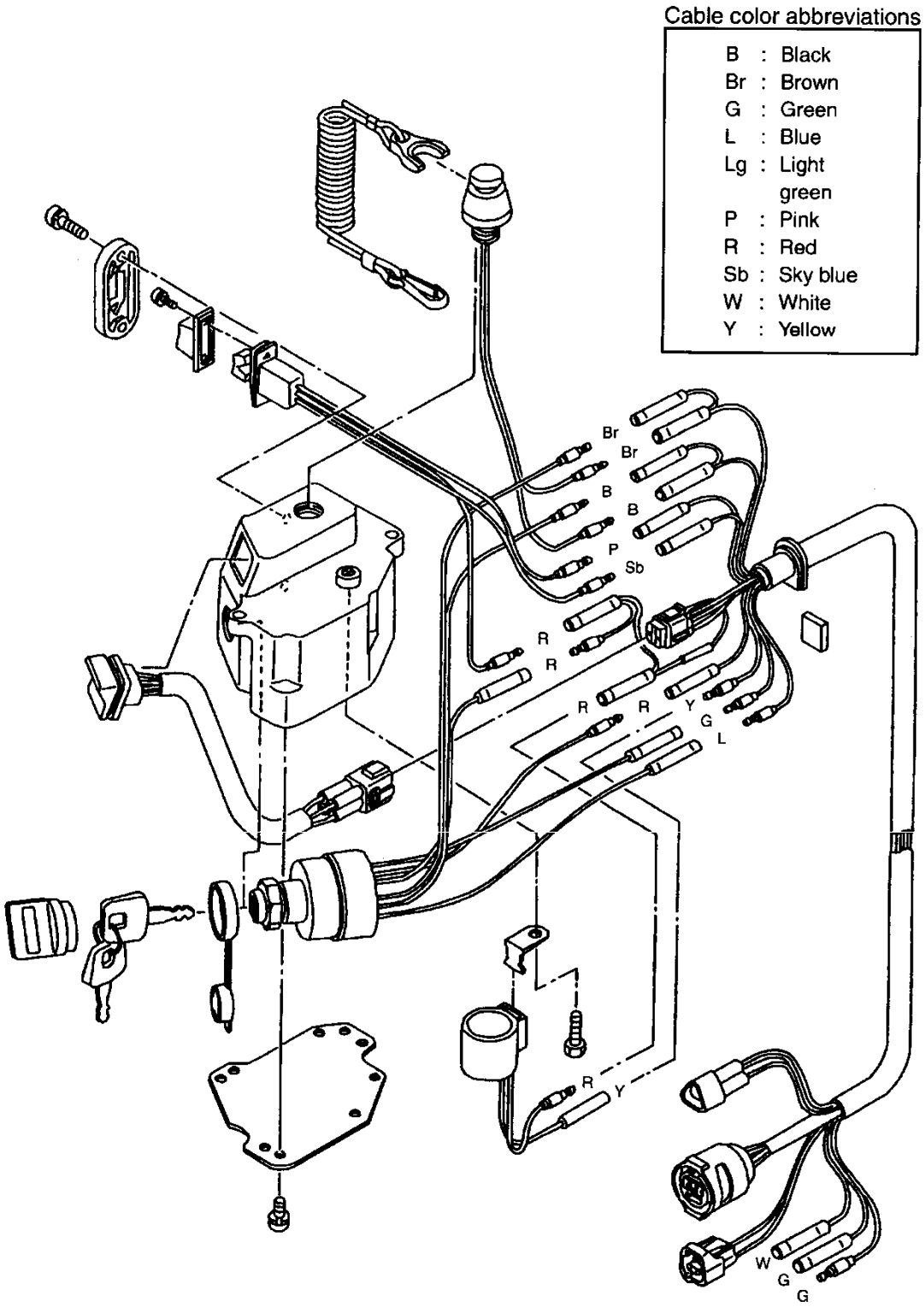
MAGNETO



ELECTRIC PARTS

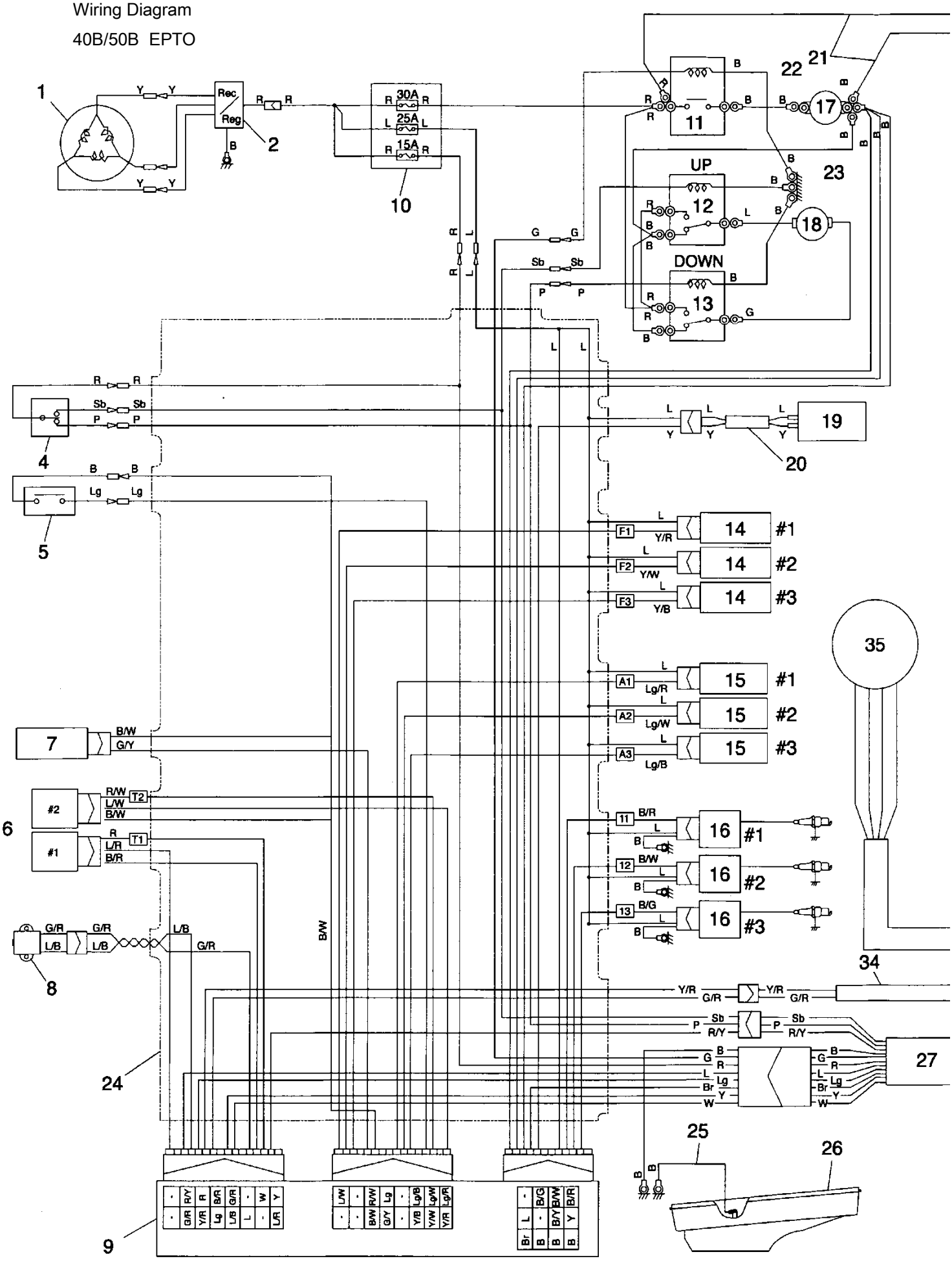


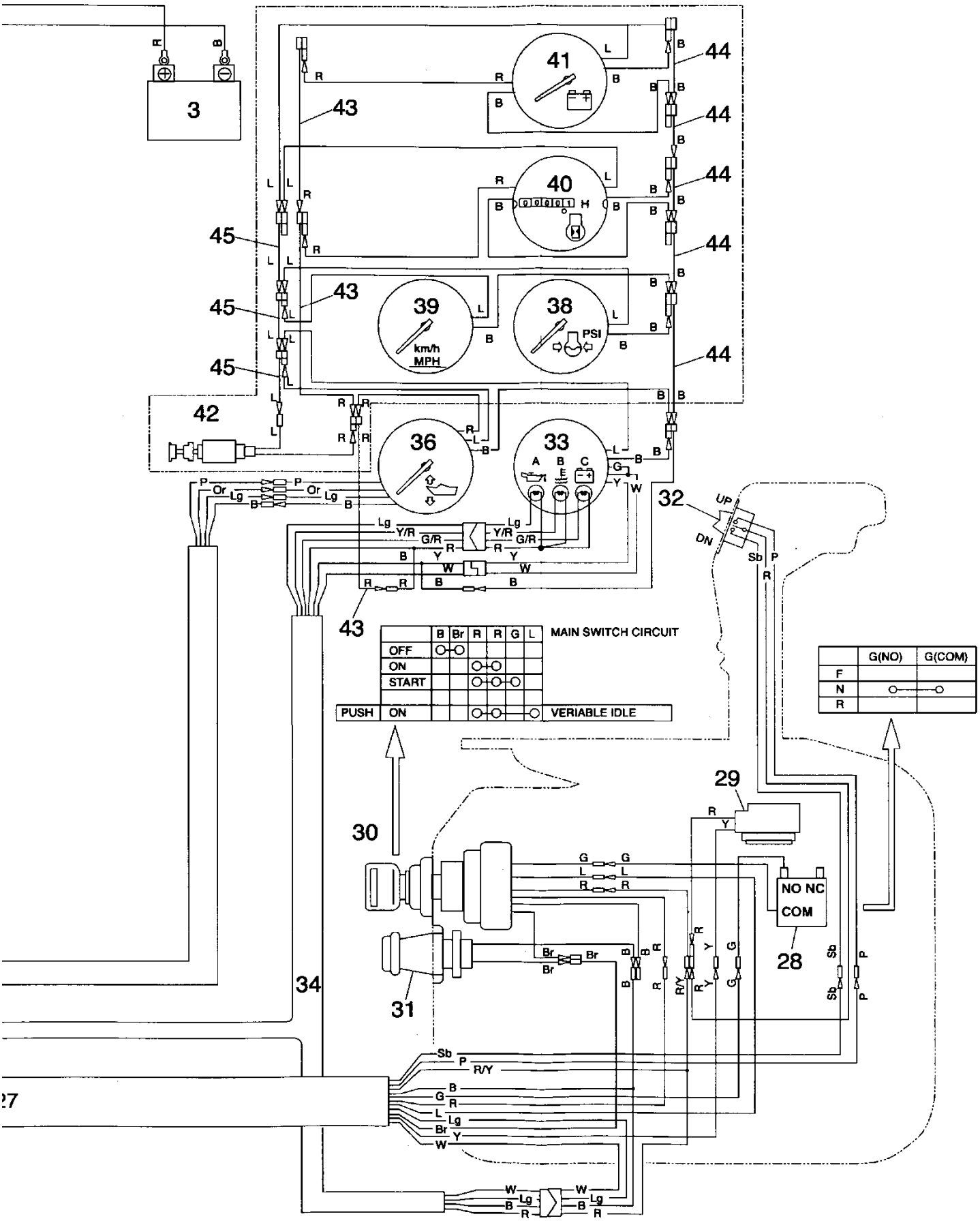
SWITCH BOX (F Type)



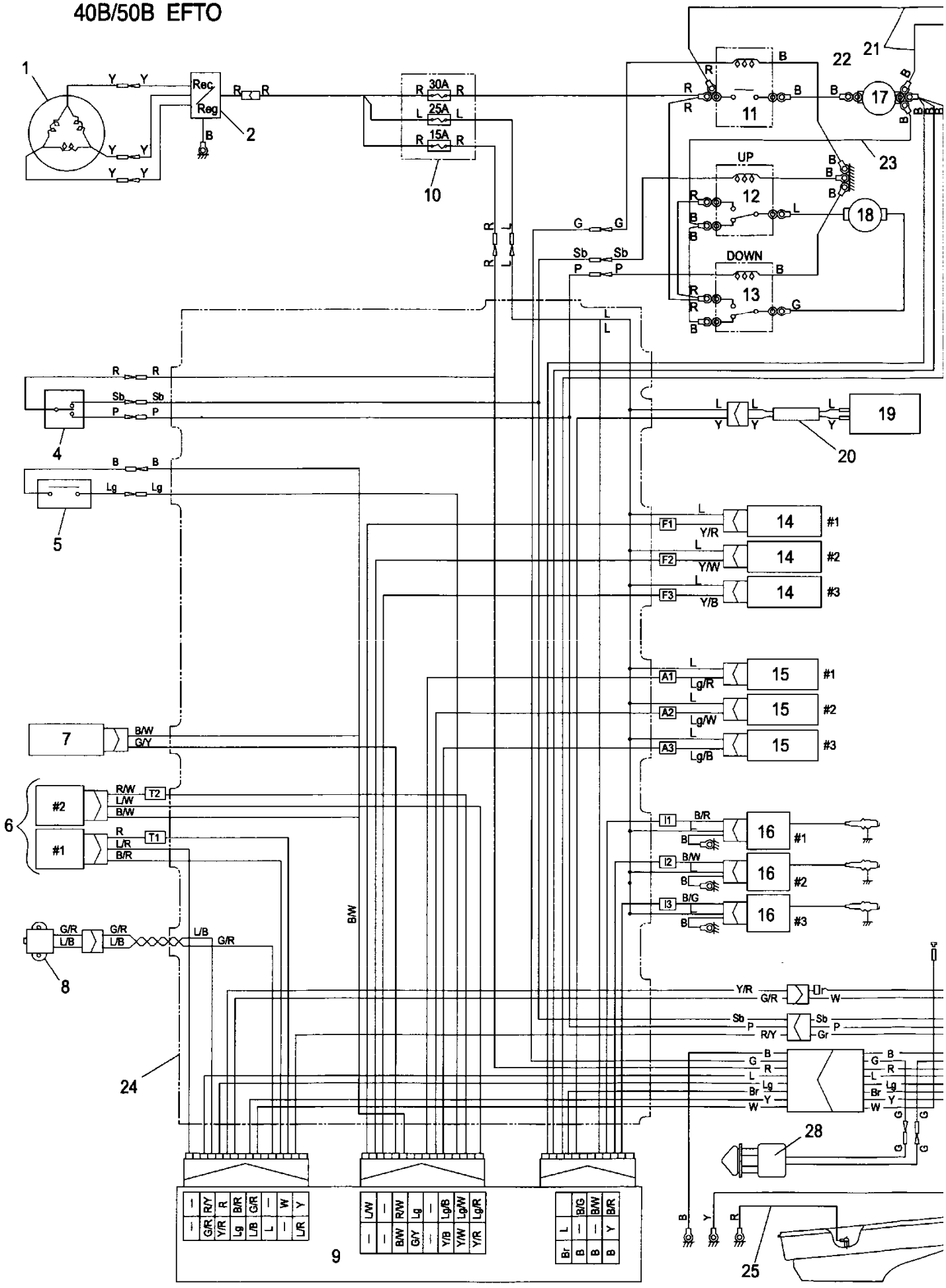
Wiring Diagram

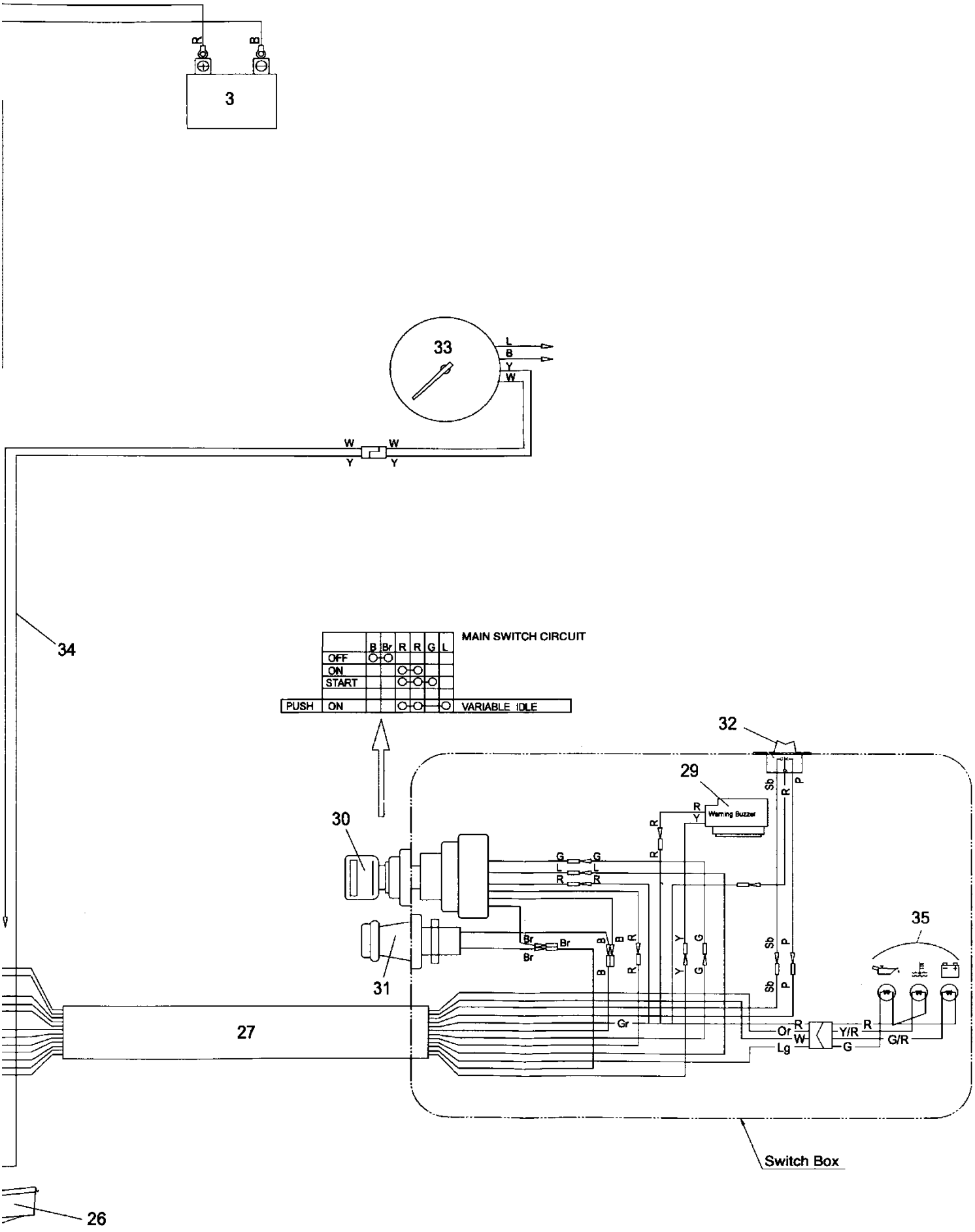
40B/50B EPTO



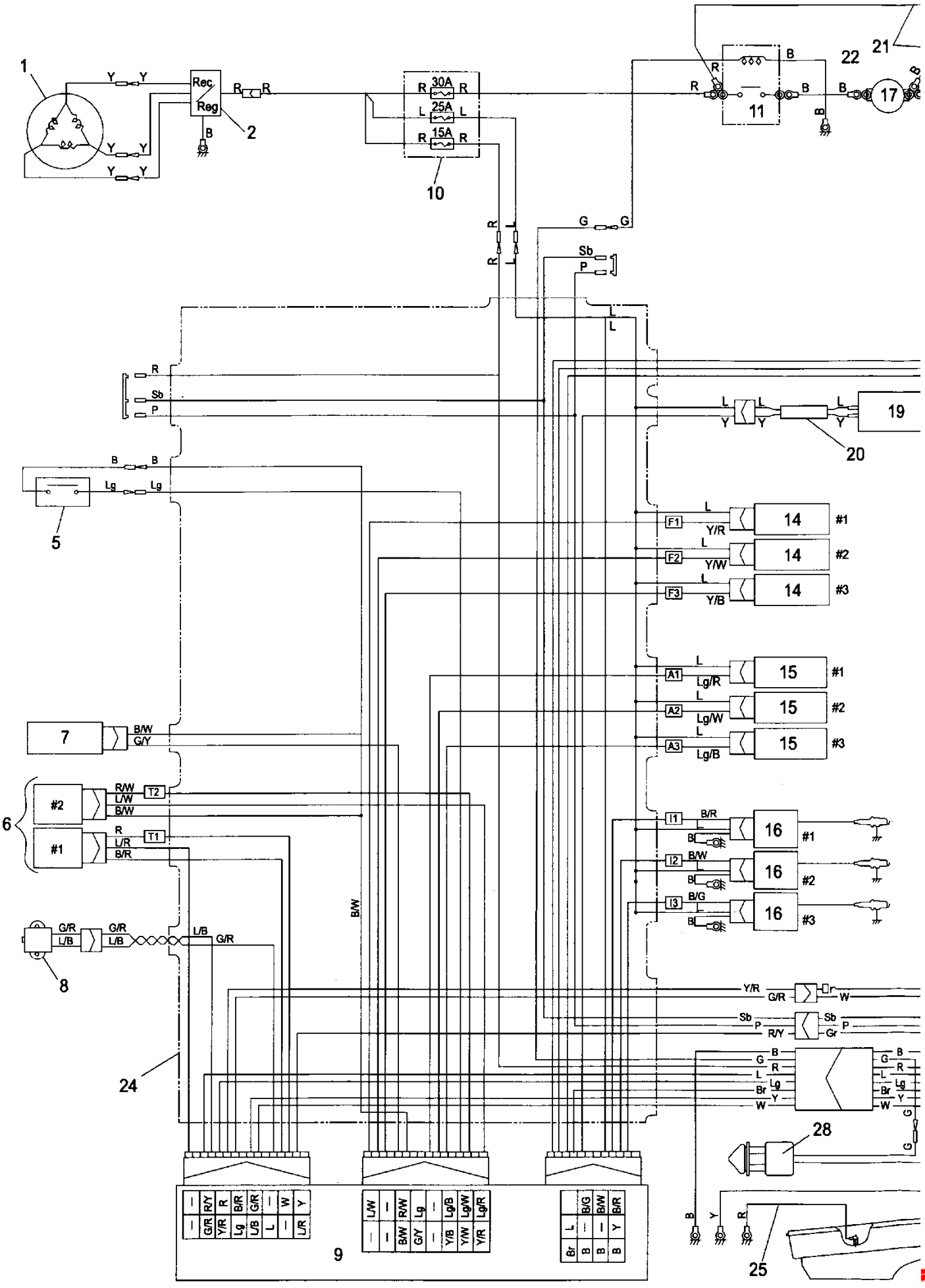

3
41
40
39
38
36
33
42
43
44
45
km/h
MPH
PSI
A B C E
32
UP
DN
Sb P R
MAIN SWITCH CIRCUIT
B Br R R G L
OFF
ON
START
PUSH ON
VERIABLE IDLE
G(NO) G(COM)
F
N
R
29
30
31
28
34
NO NC
COM
Sb P R/Y B G R L Lg Br Y W
W Lg B R

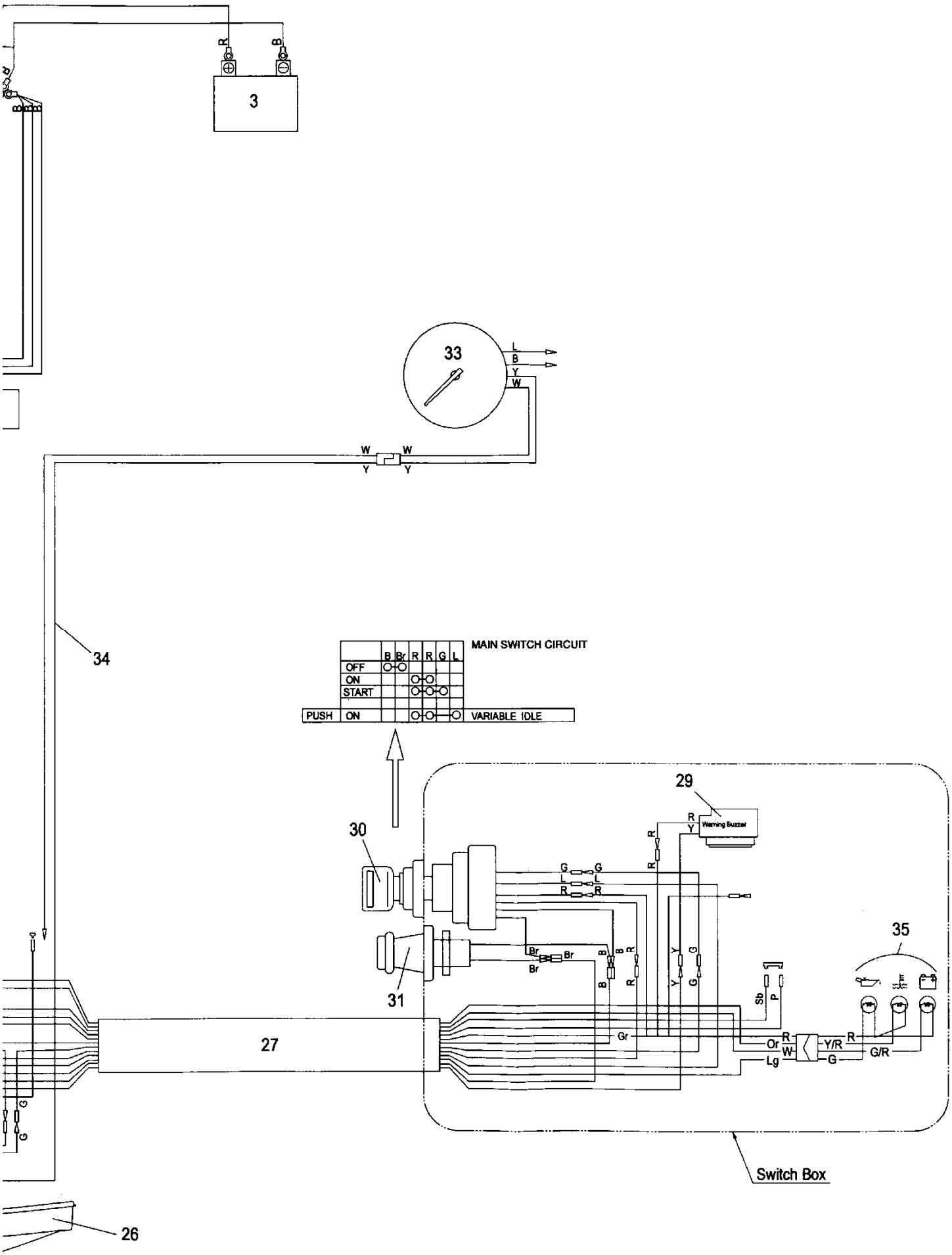
40B/50B EFTO


1
Rec
Reg
2
30A
25A
15A
10
11
12
13
UP
DOWN
17
18
19
20
21
22
23
4
5
6
7
8
9
24
25
28
F1
F2
F3
A1
A2
A3
I1
I2
I3
14
15
16
#1
#2
#3
T1
T2
B/W
G/Y
R/W
L/W
R
L/R
B/R
G/R
L/B
Y/R
Lg/R
Lg/W
Lg/B
B/R
B/W
B/G
Sb
P
G
L
Y
B
R
Lg
Br
W
Gr
R/Y


3
R
B
33
L
B
Y
W
W
Y
W
Y
34
MAIN SWITCH CIRCUIT
B Br R R G L
OFF
ON
START
PUSH ON
VARIABLE IDLE
32
29
Warning Buzzer
30
31
27
35
Switch Box
26
Gr
Or
Lg
Y/R
G
R
W
G/R
Sb
P

40B/50B EFO


1
Rec
Reg
2
B
30A
25A
15A
10
11
17
21
22
Sb
P
G
R
L
19
20
5
Lg
14
#1
#2
#3
F1
F2
F3
Y/R
Y/W
Y/B
15
A1
A2
A3
Lg/R
Lg/W
Lg/B
7
B/W
G/Y
6
#2
#1
T2
T1
R/W
L/W
B/W
R
L/R
B/R
16
I1
I2
I3
B/R
B/W
B/G
8
G/R
L/B
24
9
25
28
Y/R
G/R
W
Sb
P
R/Y
Gr
G
B
R
L
Lg
Br
Y
W


3
33
34
MAIN SWITCH CIRCUIT
B Br R R G L
OFF
ON
START
PUSH ON
VARIABLE IDLE
29
Warning Buzzer
30
31
27
35
Switch Box
26

NO	Component	NO.	Component
1	Alternator assembly	24	Cable assemblyA
2	Rectifier complete	25	Ground cable
3	Battery (obtain locally)	26	Lower motorcover
4	PTT switchB	27	Cable assemblyB
5	Oil level sensor	28	Neutral switch
6	Throttle position sensor	29	Warning horn(Buzzer)
7	Water temperature sensor	30	Main switch
8	Crank position sensor	31	Lanyard stop switch
9	ECU	32	PTT switch
10	Fuse holder assembly	33	Tachometer
11	Starter solenoid	34	Meter lead wire
12	PTT solenoid switch A	35	Trimsender
13	PTT solenoid switch B	36	Trimmeter
14	Fuelinjector	37	—
15	Air injector	38	Water pressure meter
16	Ignition coil	39	Speedometer
17	Starter motor	40	Hour meter
18	PTT	41	Voltmeter
19	FFP	42	Meter light switch
20	FFPcable	43	Assist cable,red
21	Batterycable	44	Assist cable,black
22	Startercable	45	Assist cable,blue
23	Groundcable		

*PTT: abbreviation for power trim and tilt. ECU: abbreviation for engine control unit. FFP: abbreviation for fuel feed pump.

Cable color abbreviations

B	black
Br	brown
G	green
L	blue
Lg	lightgreen
Or	orange
p	pink
R	red
Sb	skyblue
w	white
y	yellow

(Note) Slash (/)shows stripe color of cable

NO.	Component	NO.	Component
1	Alternator assembly	19	FFP
2	Rectifier complete	20	FFP cable
3	Battery(obtain locally)	21	Battery cable
4	PTT switch B	22	Starter cable
5	Oil level sensor	23	Ground cable
6	Throttle position sensor	24	Cable assembly A
7	Water temperature sensor	25	Ground cable
8	Crank position sensor	26	Lower motor cover
9	ECU	27	Cable assembly C
10	Fuse holder assembly	28	Neutral switch
11	Starter solenoid	29	Warning horn (Buzzer)
12	PTT solenoid switch A	30	Main switch
13	PTT solenoid switch B	31	Lanyard stop switch
14	Fuel injector	32	PTT switch
15	Air injector	33	Tachometer(option)
16	Ignition coil	34	Meter lead wire(option)
17	Starter motor	35	Pilot am passembly
18	PTT		

*PTT: abbreviation for power trim and tilt. ECU: Engine Control Unit

FFP: Feel Feed pump

Cable color abbreviations

B	black
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Gr	gray

(Note)Slash (/)shows stripe color of cable

NO.	Component	NO.	Component
1	Alternator assembly	19	FFP
2	Rectifier complete	20	FFP cable
3	Battery(obtain locally)	21	Battery cable
4	—	22	Starter cable
5	Oil level sensor	23	-
6	Throttle position sensor	24	Cable assembly A
7	Water temperature sensor	25	Ground wire
8	Crank position sensor	26	Lower motor cover
9	ECU	27	Cable assemblyC
10	Fuse holder assembly	28	Neutral switch
11	Starter solenoid	29	Warning horn (Buzzer)
12	—	30	Main switch
13	-	31	Lanyard stop switch
14	Fuel injector	32	—
15	Air injector	33	Tachometer (option)
16	Ignition coil	34	Meter lead wire (option)
17	Starter motor	35	Pilot l ampassembly
18	-		

PTT: abbrev 1 at 1on for power trim and bit.

Cable color abbreviations

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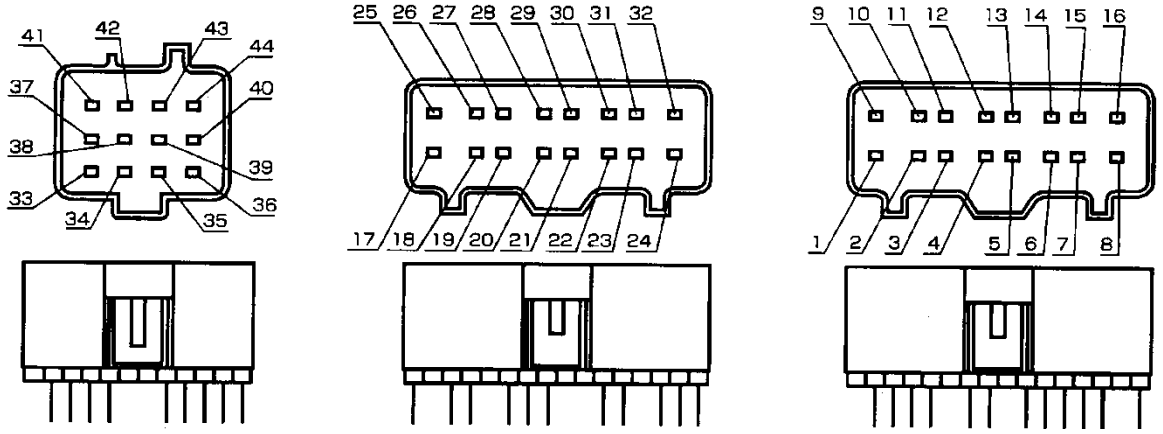
Wire Connection

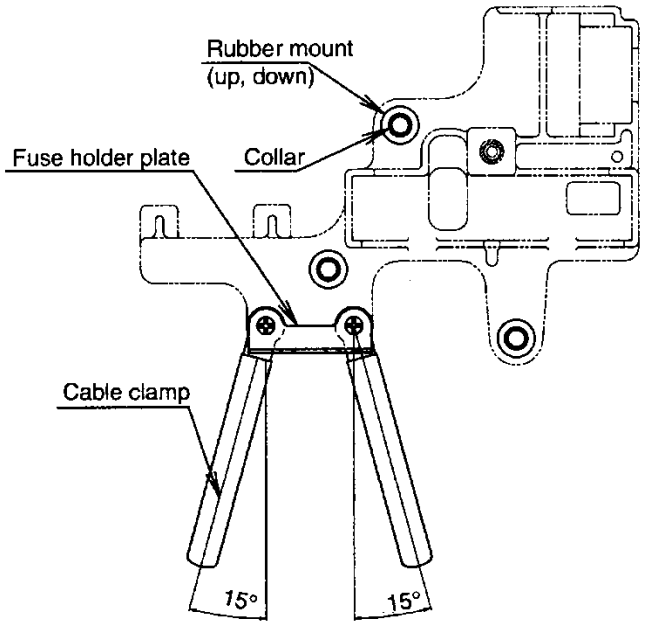


NO	Component	Cablecoloraddreviations	
1	TPS1	LIR	Blue/Red
2			
3	Keyswitch(PUSH)	L	Blue
4	CPS(Crankpositionsensor)	L/B	Blue/Black
5	Warninglamp(Oil)	L/g	lightgreen
6	Warninglamp(Temp.)	Y/R	Yellow/Red
7	Warninglamp(Battery)	GIR	Green/Red
8			
9	Buzzer	v	Yellow
10	Tachometer	w	White
11			
12	CPS(crankpositionsensor)	GJR	Green/Red
13	TPS1	B/R	Black/Red
14	TPS1	R	Red
15	keyswitch(Powersource)	R/Y	Red/Yellow
16			
17	#1Fuel injector	VIR	Yellow/Red
18	#2Fuelinjector	Y/W	Yellow/White
19	#3Fuelinjector	YJB	Yellow/Black
20			
21	WTS(Watertemp.sensor)	G/Y	Green/Yellow
22	WTS(Watertemp.sensor,TPS2andOillevelsensorGround)	B/W	Black/White
23			
24			
25	#1Airinjector	Lg/R	Lightgreen/Red
26	#2Airinjector	Lg/W	Lightgreen/White
27	#3Airinjector	Lg/B	Lightgreen/Black
28			
29	Oillevelsensor	Lg	Light green
30	TPS2	RIW	Red/White
31			
32	TPS2	L/w	Blue/White
33	Ground	B	Black
34	Ground	B	Black
35	Ground	B	Black
36	Stopswitch	Br	Brown
37	FFP(Fuelfeedpump)	v	Yellow
38	Electricoilpump(forMD70190Bonly]	B/Y	Black/Yellow
39			
40	Powersource(25AFuse,#1,2,3Airinjector,#1,2,3Fuelinjector)	L	Blue
41	#1Ignitioncoil	B/R	Black/Red
42	#1Ignitioncoil	B/W	Black/White
43	#1Ignitioncoil	BIG	Black/Green
44			

Note: Slash(/)shows stripe color of cable.

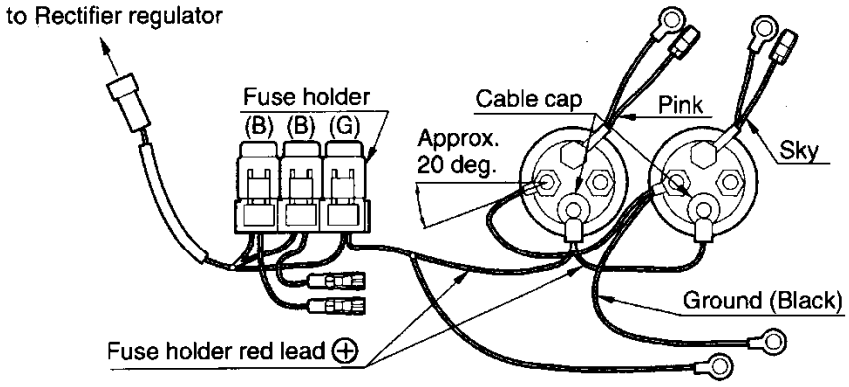
① Pre-Assembly step 1

Attach the cable clamp, fuse holder plate and rubber mount to the bracket.



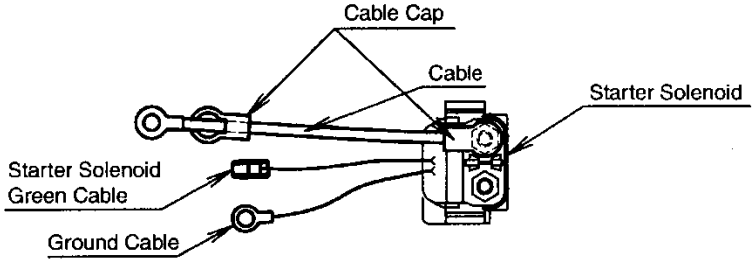
② Pre-Assembly Step 2

Attach the fuse holder red lead (+) ⓐ to the PTT solenoids and put on the cable caps.
Attach the ground cable ⓑ to the PT&T solenoids.



③ Pre-Assembly Step 3

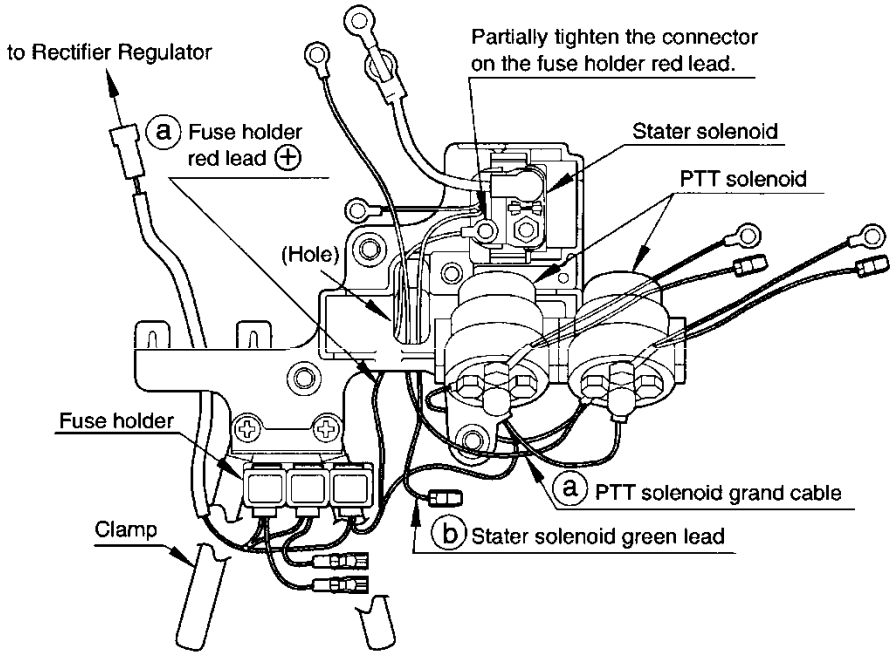
Attach the cable to the starter solenoid and put on the cable caps.



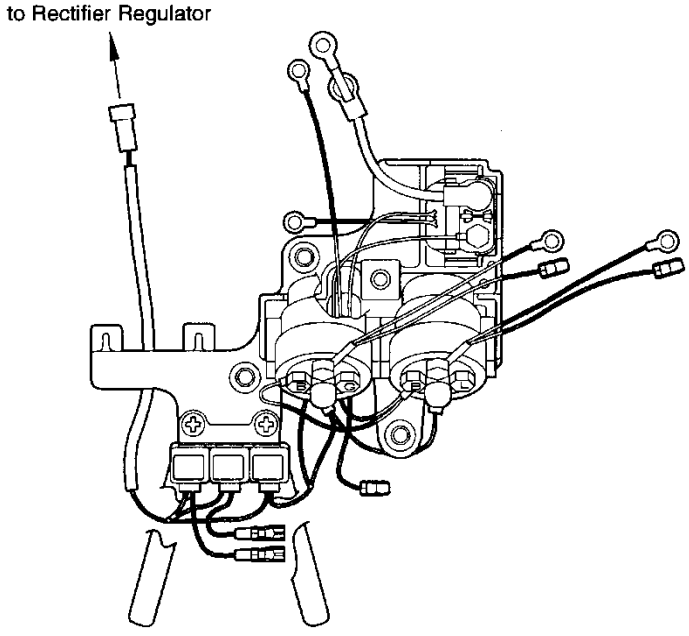
2. Assembly

④ Pre-Assembly Step 4

Pass the fuse holder red lead (+),PTT solenoid ground cable and starter solenoid green lead through the hole in the center of the solenoid bracket; then install the starter solenoid, PTT solenoid and fuse holder.



⑤ Completed Pre-Assembly

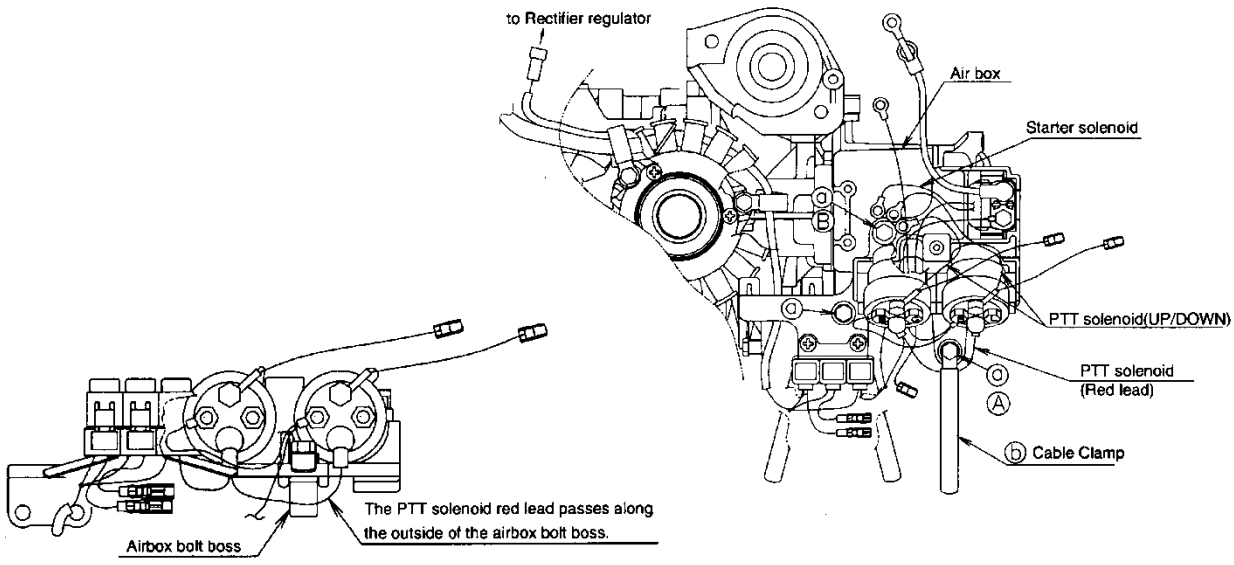


Wiring around solenoid Bracket

⑥ Assembly Step 1

Install bracket on air box.

When installing bracket be sure to install starter solenoid and PTT solenoid ground cables on bolt Ⓐ and the cable clamp on bolt Ⓑ.

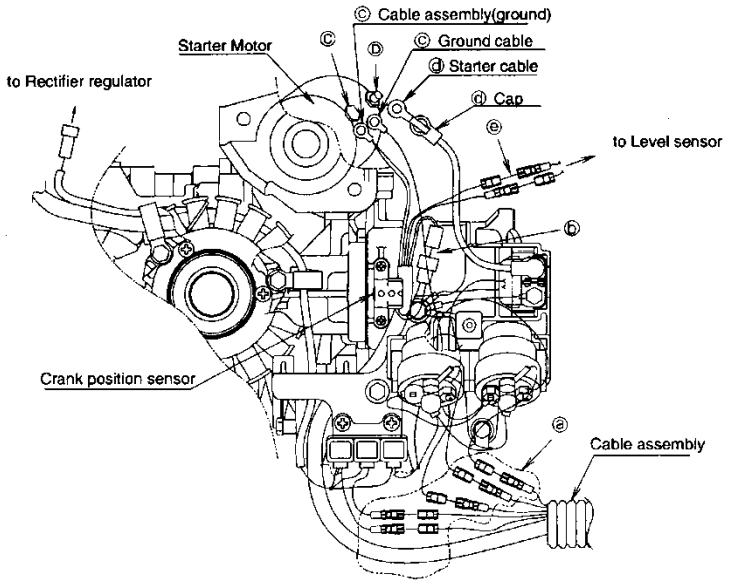


⑦ Assembly Step 2

① Install the crank position sensor and cable assembly sensor and connect wiring.

② Connect the three ground cables to the starter motor.

③ Connect wiring to the oil level sensor.

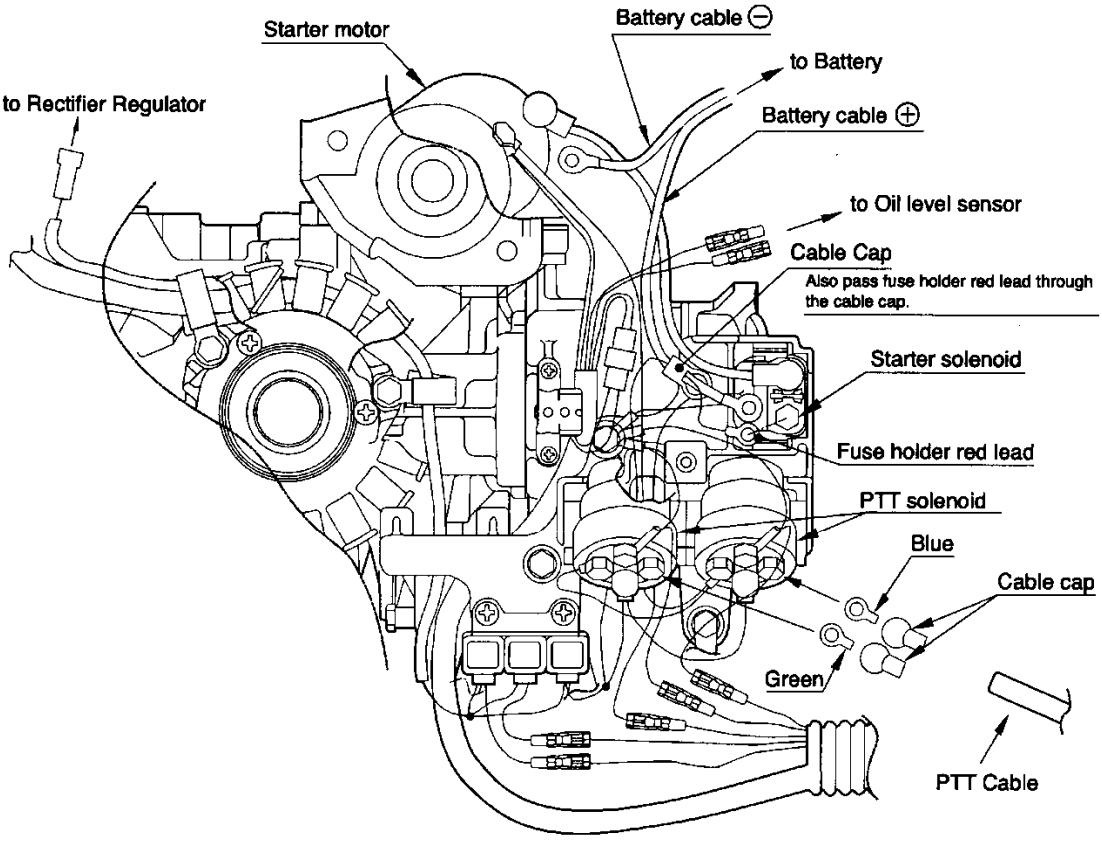


⑧ Assembly Step 3

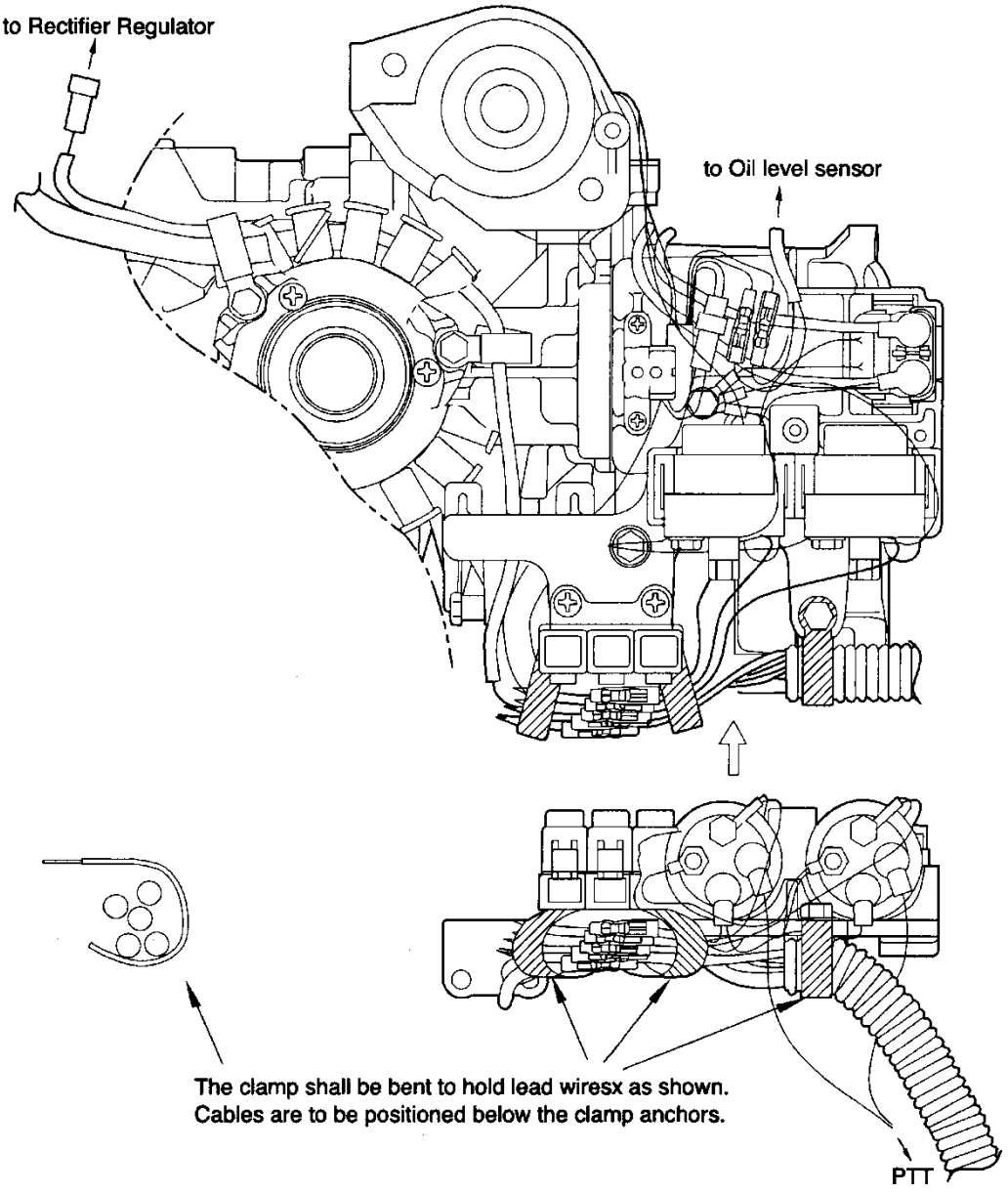
①Install the battery cable (+) in the starter solenoid. At the same time, pass the red (+) wire of fuse holder through the cable cap and install it in the starter solenoid.

②Install the battery cable (-) in the starter motor.

③Install the Blue and Green wires from PTT in the PTT solenoid and cover each terminal by the cap.



⑨ Assembly Completed



3. Inspection

Fly wheel Magneto

Precautions

Avoid applying shock or impact to the fly wheel, such as that from the tapping of a hammer.

Be sure to use the recommended tool or equivalent only .Do not use standard pulley puller obtained locally.

Always replace the fly wheel if it has been dropped on the floor or any other hard surface.

Resistance Values for Coils

These values include ignition coil, alternator coil, air injector, fuel injector and CPS(crank position sensor).

Refer to the section "Specifications and Standards Used in Servicing" in Chapter 2.

Rectifier Regulator

Inspect

For faulty connections or severed lines in the wire harness.

Measure conductivity and resistance values by referring to the check sheet table below.(Values listed are standard values.)

Disconnect wiring and measure with regulator isolated from electrical system.

Rectifier Checkpoint Table

	Tester+lead(red)					
Lead (Blac		Red	Yellow	Black	Yellow	Yellow
	Red		OFF	OFF	OFF	OFF
	Yellow	ON		OFF	OFF	OFF
	Black	ON(5kΩ)	ON (4kΩ)		ON(4kΩ)	ON(4kΩ)
	Yellow	ON	OFF	OFF		OFF
	Yellow	ON	OFF	OFF	OFF	

Note:

① Measure using the Hioki Hi Tester model 3030 or equivalent product. Do not use an insulation tester.

② The tester needle moving represents an On reading and not moving represents an Off reading. The () contain approximate values for the1kΩ range. Note that values will vary depending on tester condition (internal power supply),testing range and the individual model.

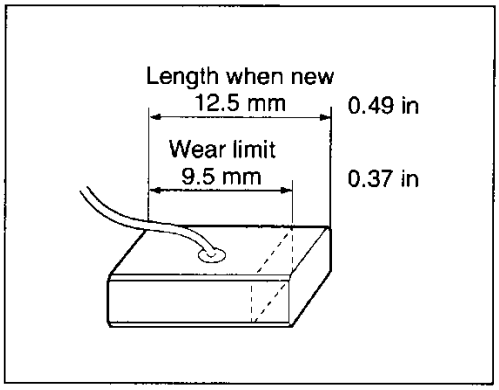
③ Be sure to disconnect any wiring connections in order to isolate each component before measuring.

④ The readings obtained using this testing procedure are not absolute values and are intended for use only as reference

Starter Motor

Brushes and Springs

① Check the brushes for wear.

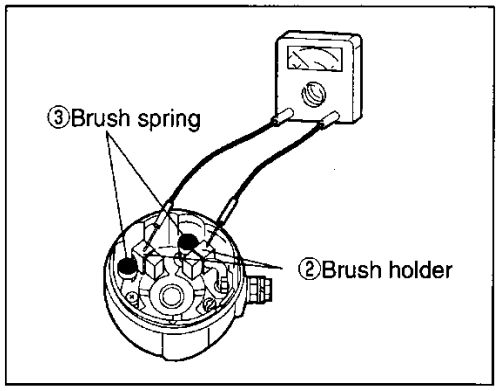


When brush length is 9.5 mm(0.37in) or less ➡ Replace with new one.

② Inspect insulation between brush holders.

If conductive, determine cause or replace insulation.

③ Brush spring tension

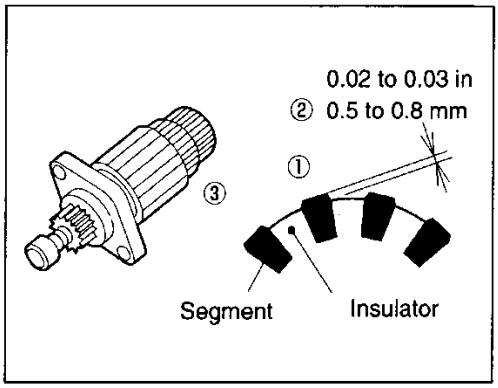


When there is a loss of tension ➡ replace spring.

Armature

① Measure the depth of the insulator on the commutator.

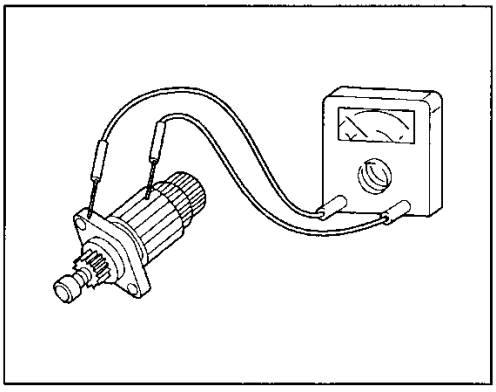
② When the distance at location ® does not fall within the 0.5 to 0.8 mm (0.02to0.03in) range or when deformed from excessive wear ,repair the teeth attached to the plate so that they conform to the designated range.



③ To remove excessive carbon buildup on the commutator, select a sand paper in the #500 to #600 range.

④ the armature insulation.

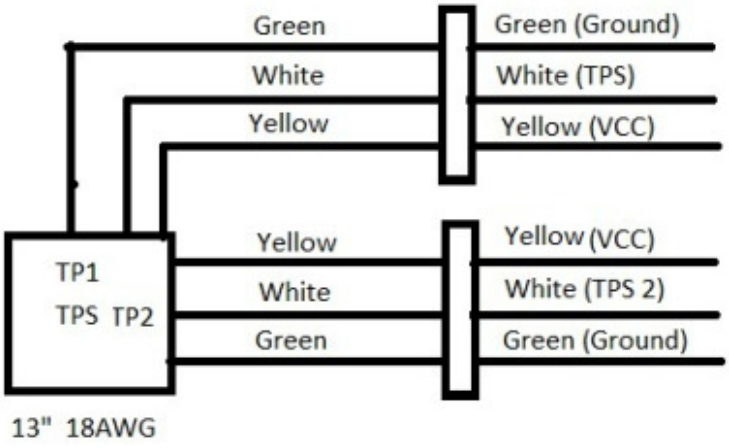
When conductive ➡ Replace starter motor assembly.

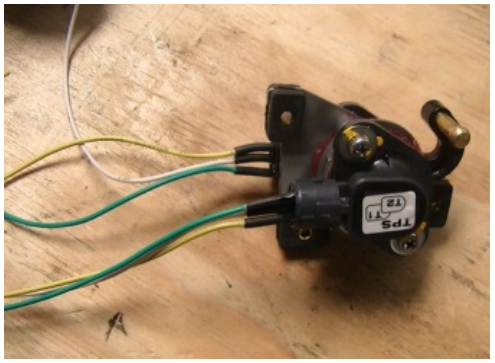


5. Multi-Fuel Electrical layout

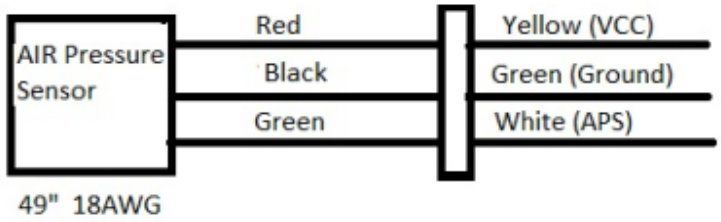
Connectors and wire pin outs

Throttle Positioning Sensor

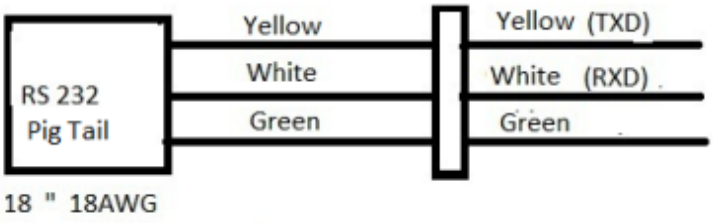




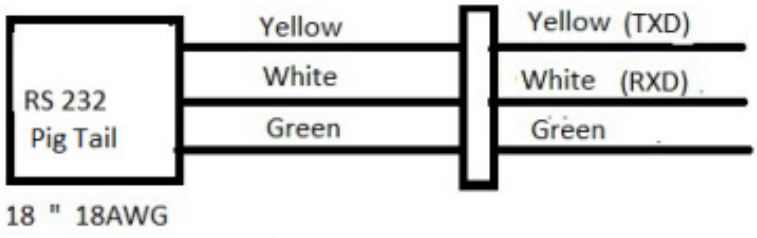
Air Pressure Sensor

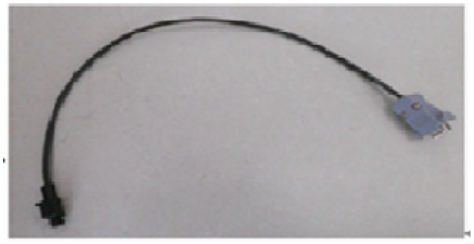


RS 232 Pig Tail

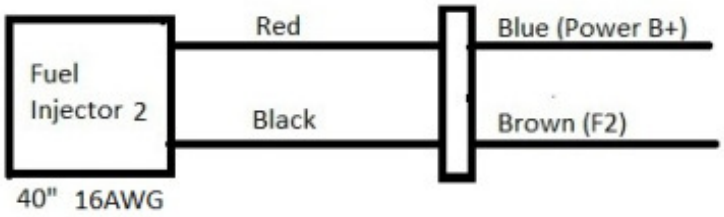


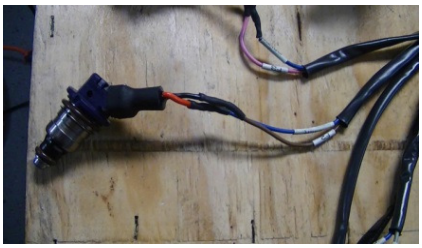
RS 232 Pig Tail



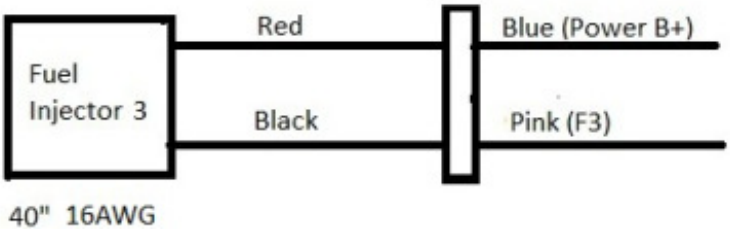


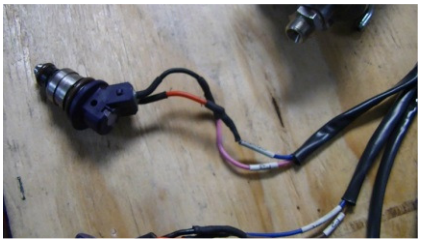
Fuel Injector (3)



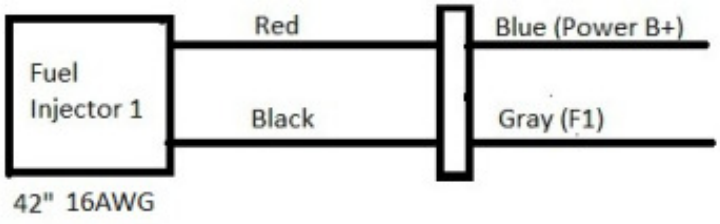


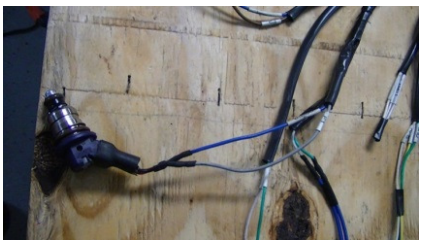
Fuel Injector (2)



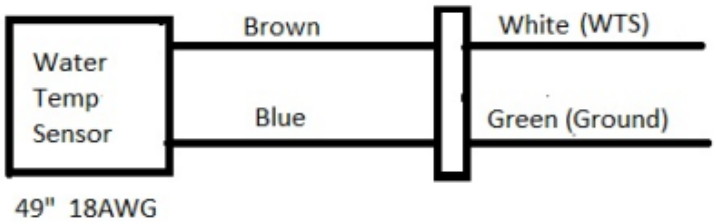


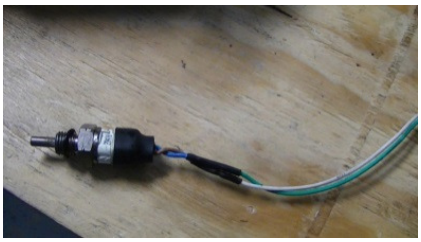
Fuel Injector (1)



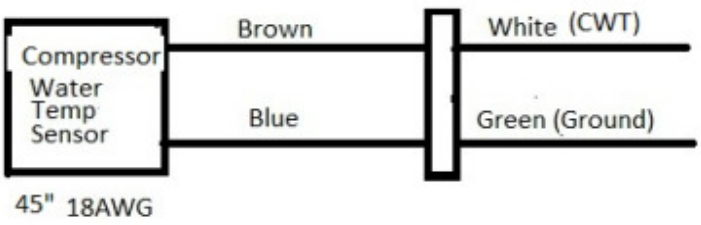


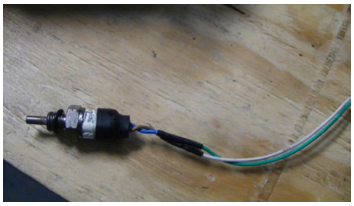
Water Temp Sensor



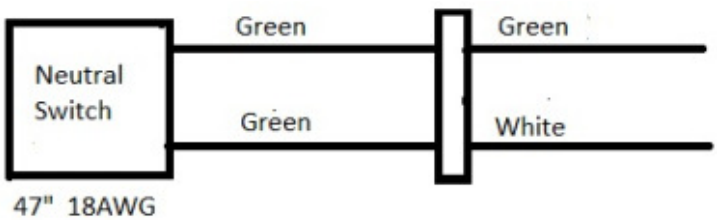


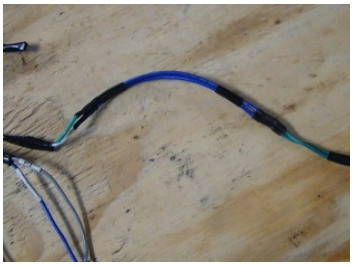
Compressor Water Temp Sensor



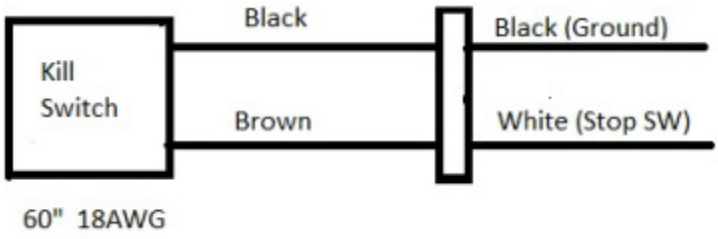


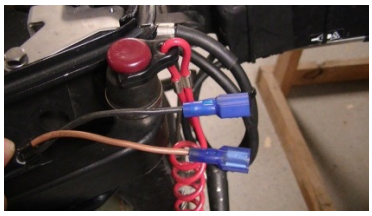
Natural safety switch



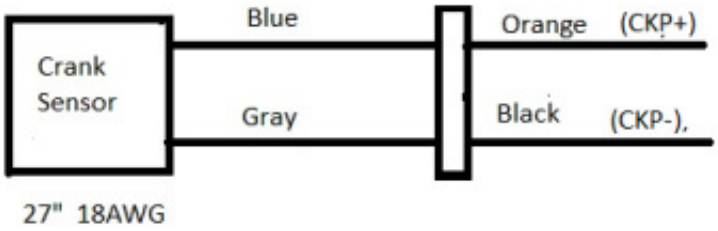


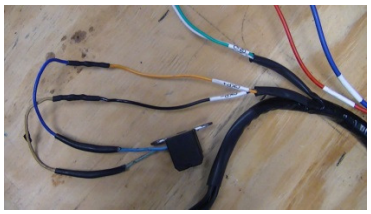
Kill Switch



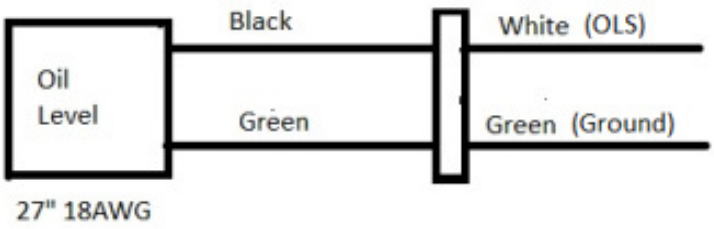


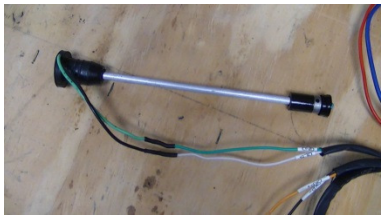
Crank Sensor



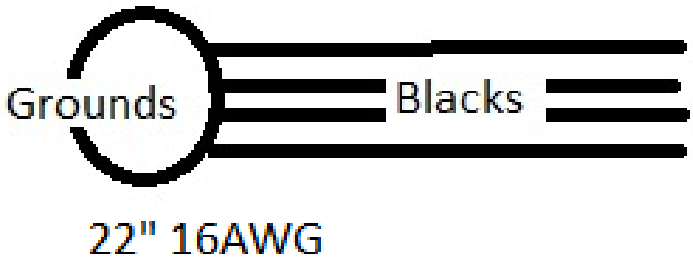


Oil Level Sensor

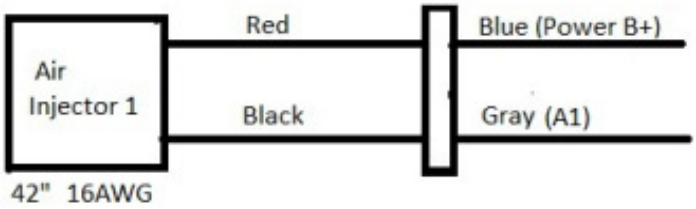


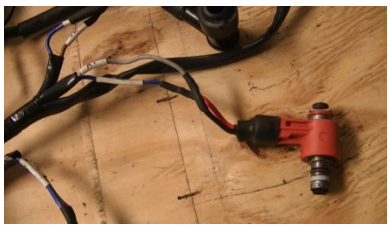


Grounds

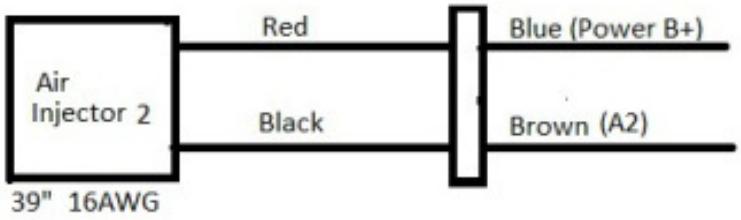


Air Injector (1)

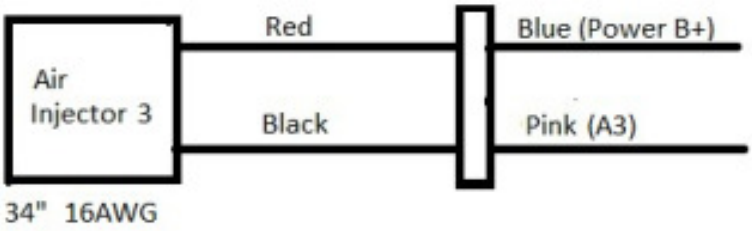




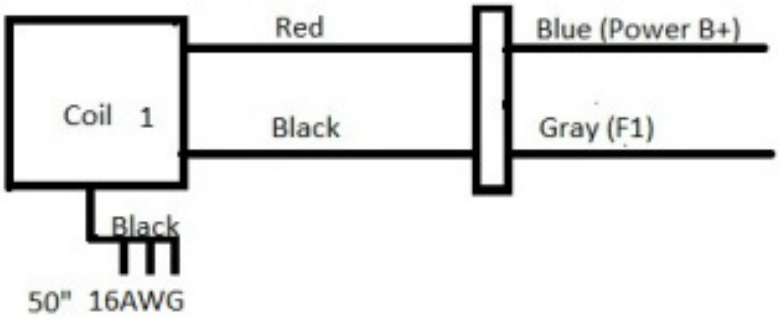
Air Injector (2)



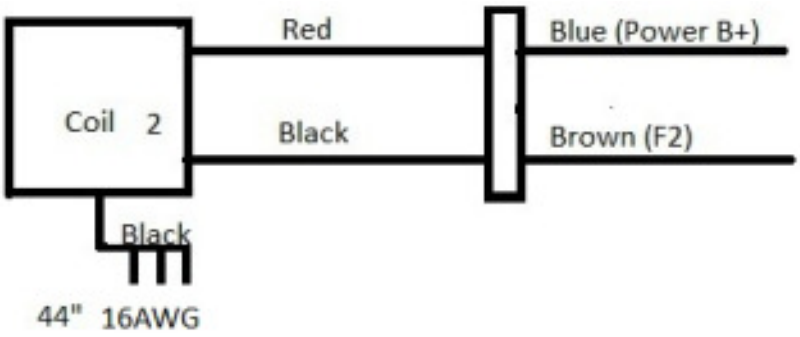
Air Injector (3)



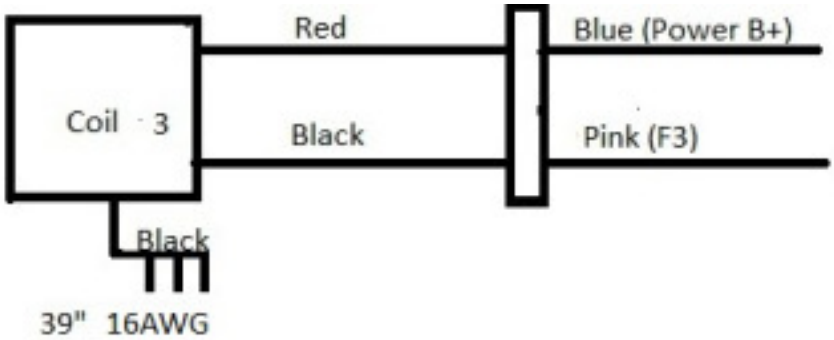
Coil (1)



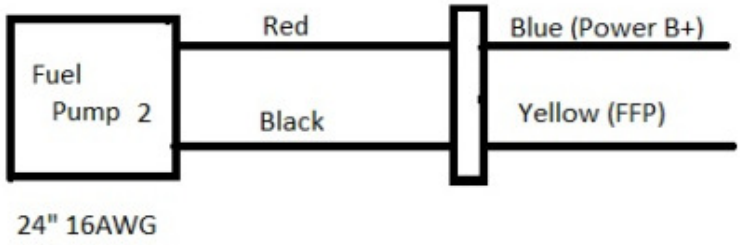
Coil (2)

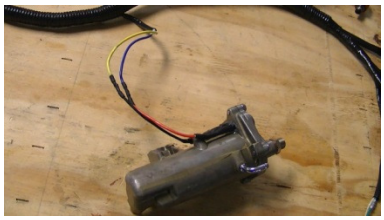


Coil (3)

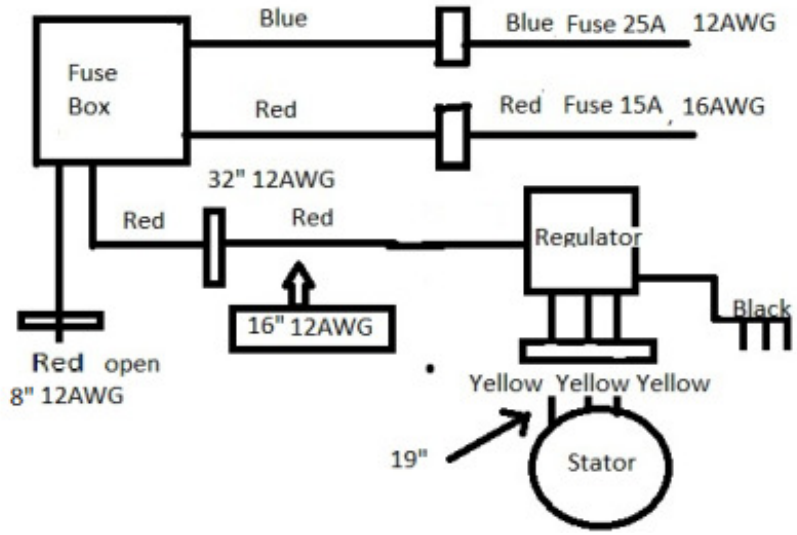


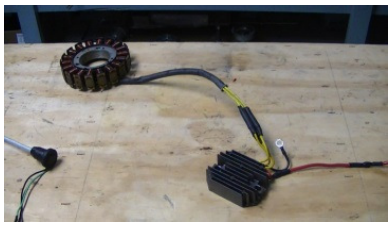
Fuel Pump

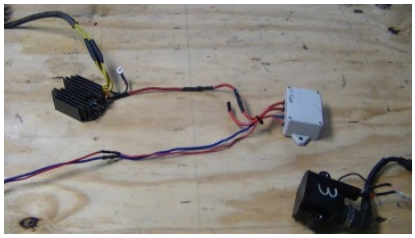




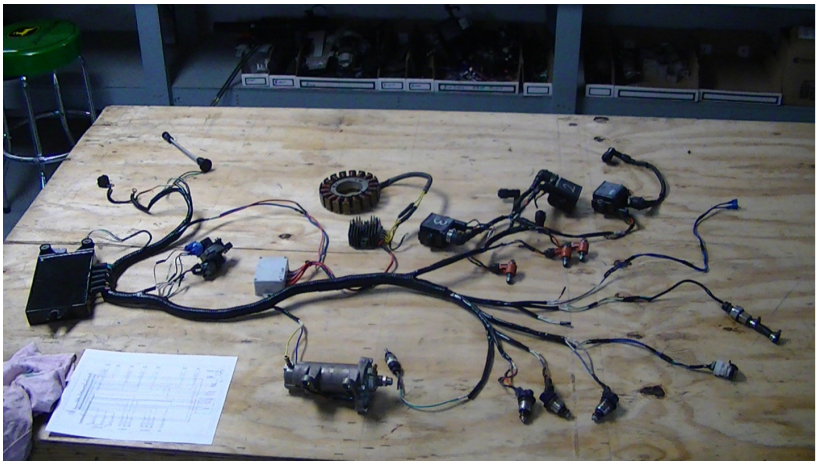
Fuse Box- Regulator - Stator







Complete Wiring harness

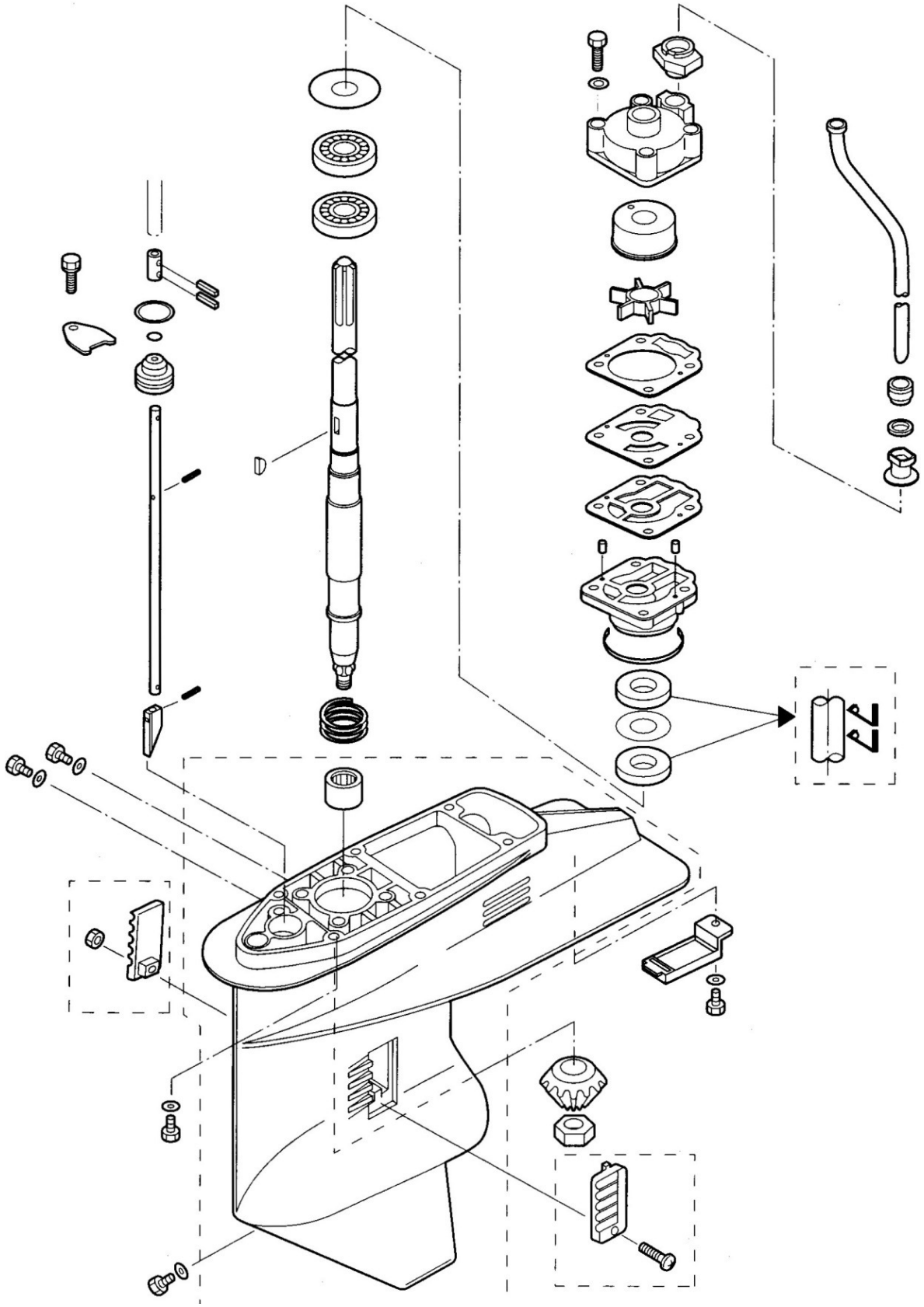


Chapter 6 Disassembly, Inspection and Reassembly Lower Unit

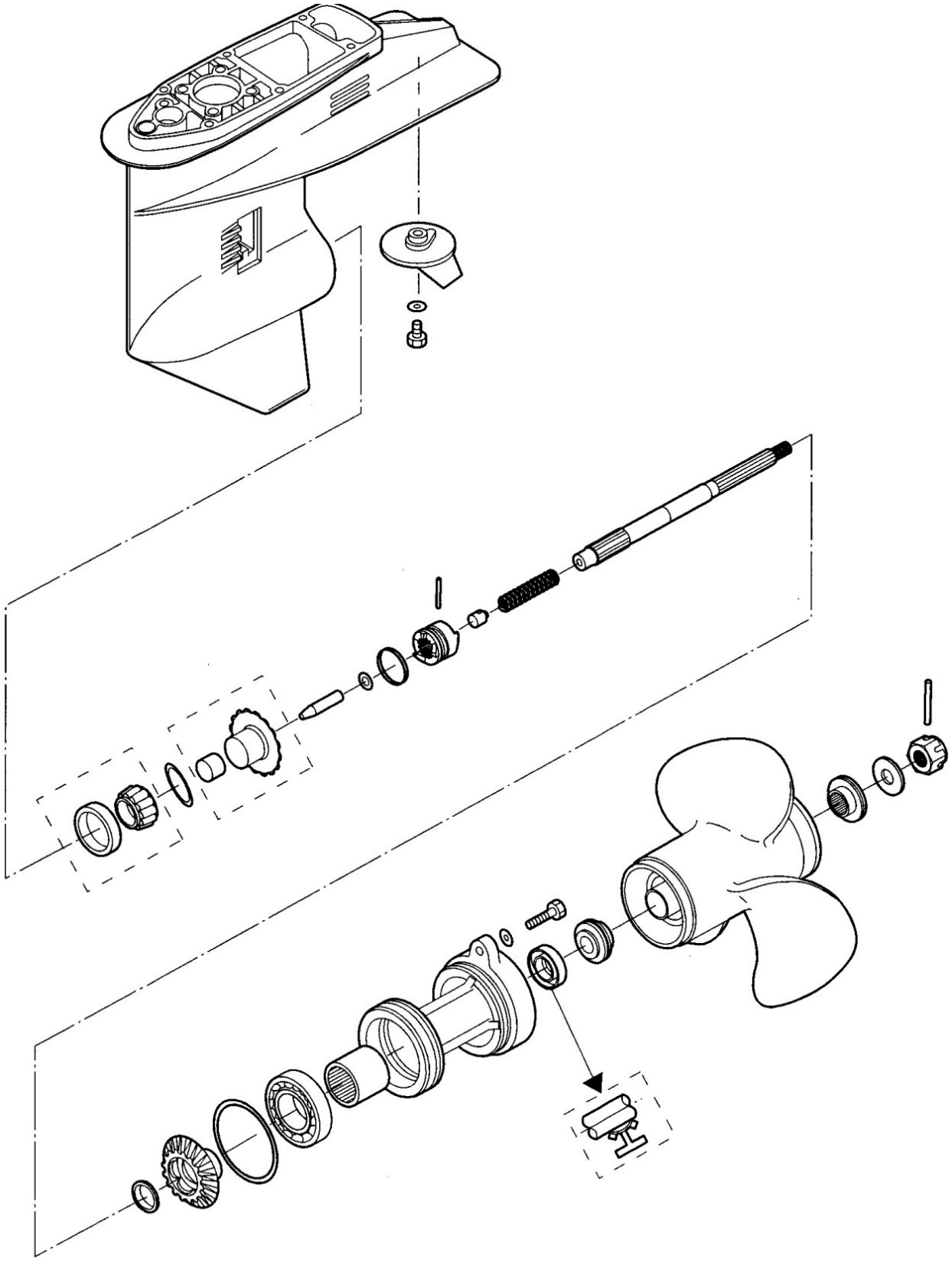
6

1. Configuration

GEARCASE(DRIVESHAFT)



GEARCASE(PROPELLERSHAFT)



2. Disassembly

Caution:

- Begin the procedure by first removing the spark plug caps and then removing the sparkplugs.
- When working with the outboard engine tilted full up,make sure to secure the engine firmly in place using a tilt up stopper.
- In cases where the outboard engine (S and L shaft models) is not mounted on its board,it is important to take care that the bracket spring up when the reverse lock lever is released.

(Inspection and Maintenance).

Disassembling Gear Case

The gear case can be disassembled from this outboard engine without having to remove the power unit.

Removing Propeller

Remove The Following Components.

① Split pin

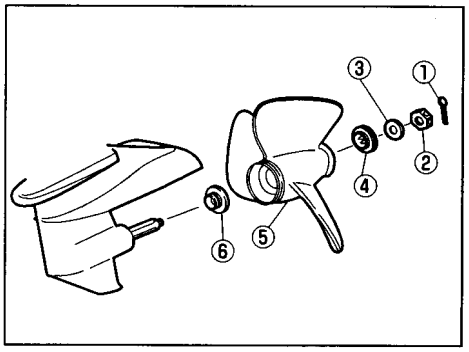
②Propeller nut

③ Washer

④ Stopper

⑤ Propeller

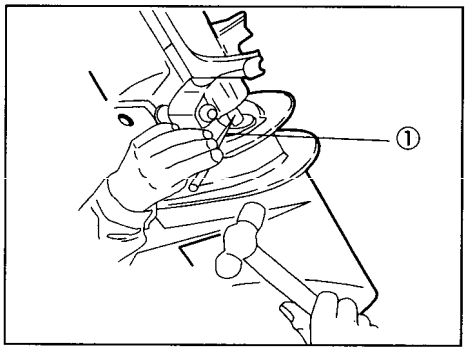
⑥Thrust holder



Removing Gear Case

Remove the following components.

① Split pin

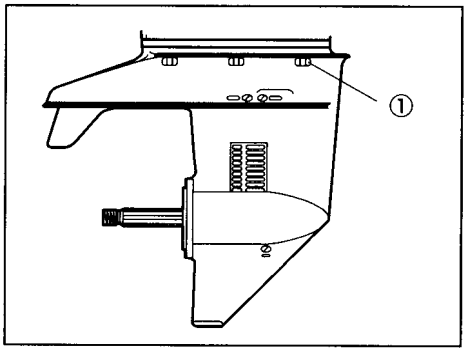


Special Tool	Spring pin tool A
	345-72227-0

Remove the following components.

①Bolt: type H835 at 6 locations

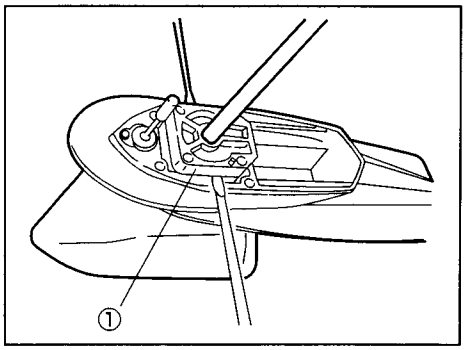
② Gear case assembly (remove in downward motion.) 1



Draining Gear oil

Refer to section on inspecting gear case contained in Chapter 3

Disassembling Water Pump Case

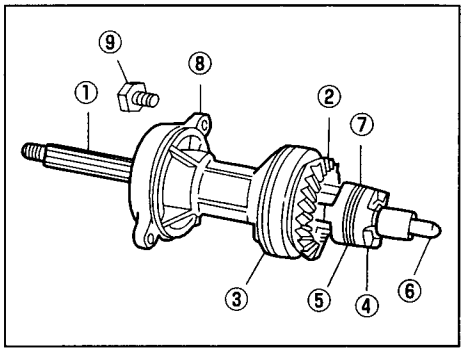


① Remove the lower section of the water pump case.

Remove by inserting a flathead screw driver along the case removal groove.

Disassembling Propeller Shaftand Clutch

Remove the various components using the following procedures.



⑨ Bolt:type H 625 at 2 locations

⑧ Propeller shaft housing (with ① to⑦)

⑤Clutch pins napring ➡ Replace with new pin

⑦ Clutch pin

Press lightly on ⑧ in order to remove clutch pin ⑦.

① Propeller shaft

② Bevel gear, C

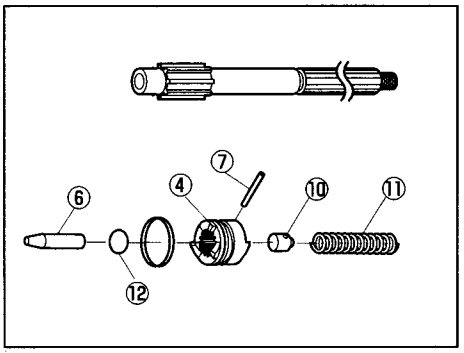
③ 0-ring

④ Clutch

⑤Clutch pins napring

⑥ Pushrod

⑧Propeller shaft housing



Take care when removing ⑦ as the push rod ⑥,clutch spring holder ⑩ and steel ball ⑫are liable to spring out.

Remove the following components.

④ Clutch

⑥ Pushrod

⑩ Clutch spring holder

⑪ Clutch spring

⑫ Steel ball

Removing Bevel Gear and Drive Shaft

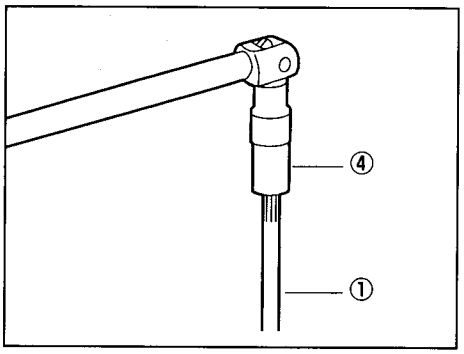
Remove the following components.

1. Bevel gear B nut
2. Bevel gear B
3. Drive shaft
4. Bevel gear A
5. Bevel gear A bearing
6. Bevel gear C

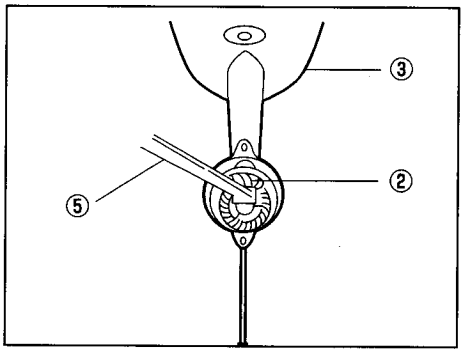
Removal Procedure

1. Insert ④ onto spline ①
2. Attach ⑤ to ②.

Special Tool	⑤Bevel gear B nut wrench: 346-72231-0
	④Bevel gear B nut socket: 346-72232-0



3. Turn ⑤ to loosen nut ② and remove.
4. Remove ②.
5. Remove ①.



①Driveshaft
②Bevel gear B
③ Gear case
④Bevel gear B nut socket
⑤Bevel gear B nut wrench

3. Inspection

Inspect the following components.

Component	Inspection points	Remarks
Bevel gears A,B,C and clutch	• Wear and damage on pawls of bevel gears A and C. • Wear and damage on clutch pawl. • Meshing of bevel gears A,B and C and back lash*. • Wear on bearings for bevel gears A and C.	Replace. Replace. Replace as necessary. Replace as necessary.
Propeller shaft	• Play between clutch and spline.	Replace as necessary.
Driveshaft	• Misalignment of driveshaft. • Wear on spline area. • Wear contact surface of needle roller bearing.	Replace.* Replace as necessary. Replace as necessary.
Water pump	• Wear on pump impeller. • Wear and defamation of pump case liner. • Wear on pump guide plate. • Wear and cracking on the lip area of pump case lower oil seal.	Replace. Replace. Replace as necessary. Replace as necessary.

* : Refer to the table on the next page listing the backlash readings and corresponding adjusting shim sizes.

* :Refer to Chapter 2-2

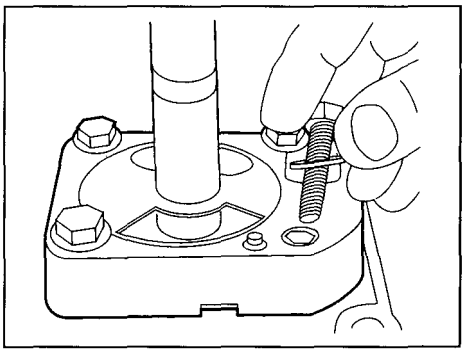
.

Gear Backlash

PositioningBevelGear8:ShimmingGauge

Positioning of bevel gear B must be performed prior to the back lash measurement.

Special Tool	Shimming gauge	387-72250-0
	Thickness gauge	353-72251-0



Checking

1. Instal lower pump case to fix driveshaft.

Note: use bolt and plain washers.

Tightening torque
11–15N-m(1.1–1.5kg-m)[8–11lb-ft]

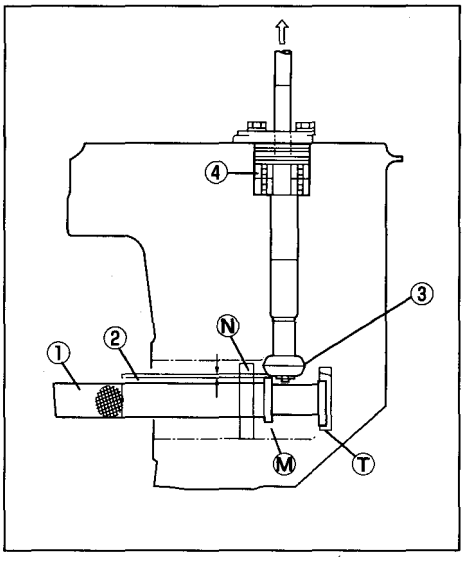
2. Install bevel gear B ③.

Tightening torque
40-58N-m(4-6kg-m)[29-44lb-ft]

3. Insert shimming gauge ①.

Note:*Taper (T) must be contacted to bearing outer surface firmly.

*Opening slit of shimming gauge at (N) must be at the position12 o'clock.



4. Measure the gap between (M) position of gauge and bevel gear B with thickness gauge②.

Note:When measuring,drive shaft must be pulled up as shown as a narrow mark completely so as not have any play.

Gap	0.6-0.64mm(0.0236-0.0252in)

5. If the gap is not in the specified range ,adjust the gap with the shim.

Shim	Location
①0.1mm(0,00394in) ②0.15mm(0.00591in) ③0.3mm(0.01181in)	Between Lower pump case and bearing.

Inspecting Bevel Gear Backlash

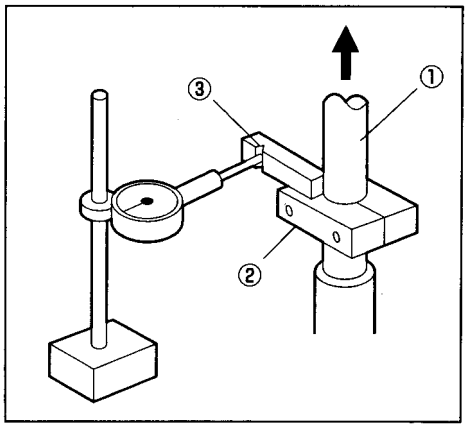
Backlash MeasuringTool

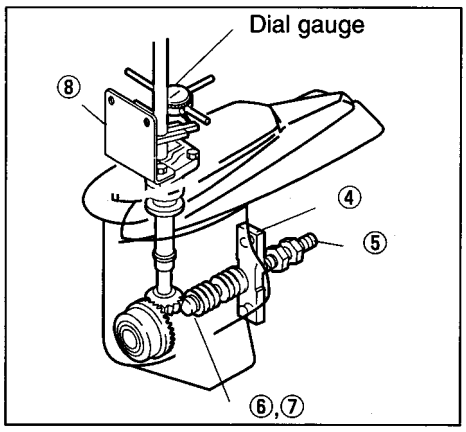
Install the clamp assembly ② on the drive shaft

①.LineupthetipofthedialgaugewithcenteroftheVgroove ③ on the clamp assembly.

①Driveshaft

Special Tool	② Clampassembly:3B7-72720-0 ④ Plate :3A3-72713-0 ⑤ Shaft :345-72723-0 ⑥ 0-ring :332-60002-0 ⑦ Collar :353-72245-1 ⑧ Plate :3B7-72729-0





1. SecurelytightenthetoolsecuringbevelgearAtoensureitdoesnotmovetogetherwiththedrive shaftwhenthe shaftrotates.
2. Installoftheupperandlowerpumpcasesonthegearcasewiththepumpimpellernotyetinstalle d.Installsothattheclampassembly②ispositioned asclosetothepumpcaseas possible.
3. Withthegearcaseanddialgaugestationery,pull uponthedriveshaft①whilerotatingitandtakeadialgaugereading.This techniqueisusedtopreventdriveshaftplayfromaffectingdialgaugereadings.

BacklashReadingandCorrespondingadjustingshimsizes

	Gaugereading
Backlash	0.31to0.62mm 0.0119to0.0244in

Notes:

1. Thevalueslistedinthetablerepresenttherangeofdial gaugereadingstakenusingthevariousspecialstools.
2. Replaceshimsasnecessaryinordertoadjusttotherequiredthickness. A+signindicatesthat shimthicknessshouldbeincreased,whilea- signitshouldbedecreased.
3. Itisimportanttorepeatthemeasuringprocedureseveraltimesinorderto obtainanaccuratebacklashreading.

Example:

Shimreplacement isunnecessary incaseswherebacklashvaluesfallwithinthedesignatedrange.

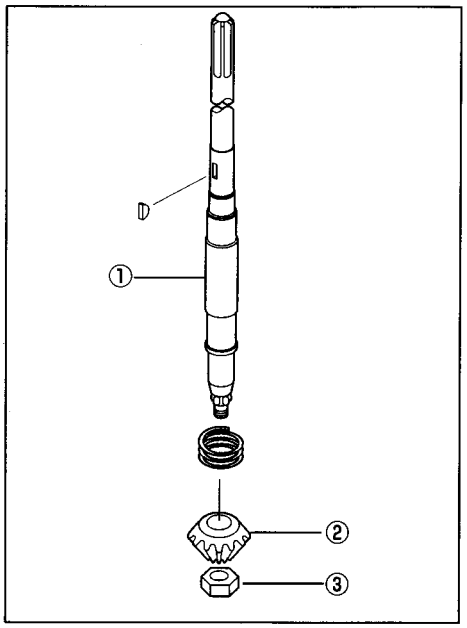
Asanexample,ashimof0.15mm(0.0059in)shouldbeaddedforadialgaugereadingof1.00mm(0 .0394).

Shimsize:mm	Location
0.1'0.3,0.5 (0.0039,0.0118,0.0197in)	Betweenlowerpumpcaseand bearing.
0.1,0.15,0.3 (0.0039,0.0059,0.0118in)	BetweenbevelgearAandbearing.

Gaugereading(mm)	Shimsize(mm)
0.00to0.16	-0.10
0.17to0.30	-0.05
0.31to0.62	+0.00
0.63to0.74	+0.05
0.75to0.94	+0.10
0.95to1.13	+0.15
1.14to1.33	+0.20
1.34to1.52	+0.25
1.53to1.72	+0.30
1.73to1.92	+0.35
1.93to2.11	+0.40
2.12to2.31	+0.45
2.32to2.51	+0.50

Gaugereading(in)	Shimsize(in)
0.0000to0.006	-0.0039
0.0064to0.011	-0.0020
0.0119to0.024	+0.0000
0.0254to0.029	+0.0020
0.0292to0.037	+0.0039
0.0371to0.044	+0.0059
0.0446to0.052	+0.0079
0.0525to0.059	+0.0098
0.0599to0.067	+0.0118
0.0678to0.075	+0.0138
0.0757to0.083	+0.0157
0.0832to0.090	+0.0177
0.0910to0.098	+0.0197

4. Reassembly



AssemblingGearCase

Observetheprecautionarynotesprovidedatvariousstepswhileassemblingint hereverseorderofdisassembly.

InstallingBevelGearonDriveShaft

Installthefollowingcomponents.

- BevelgearAbearing

Usetheouterracetopressfitthebearinginplace.

①Driveshaft

②BevelgearB

③BevelgearBnut

Torque:40to58N-m(4to6kg-m)(29to43lb-ft}

Special Tool	BevelgearBnutwrench:346·72231·0
	BevelgearBnutsocket:346·72232·0

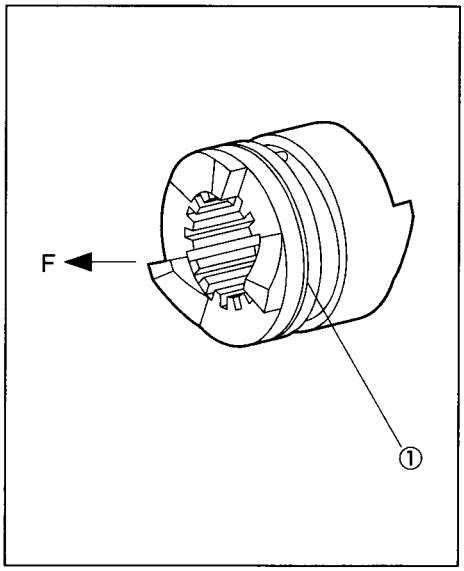
ApplyingAdhesive

Driveshaft*	Overentirethreadarea	ThreeBond1373B
BevelgearBnut		

*:Becarefulnottogetanyadhesiveonthesplineandtaperedsurfacearea.

AssemblingPropellerShaftandClutch

Assemble inreverseorderofthedisassemblyprocedure.



Directionof Clutch

InstallwiththegrooveⒾsidefacinginbevelgearA(directionF).

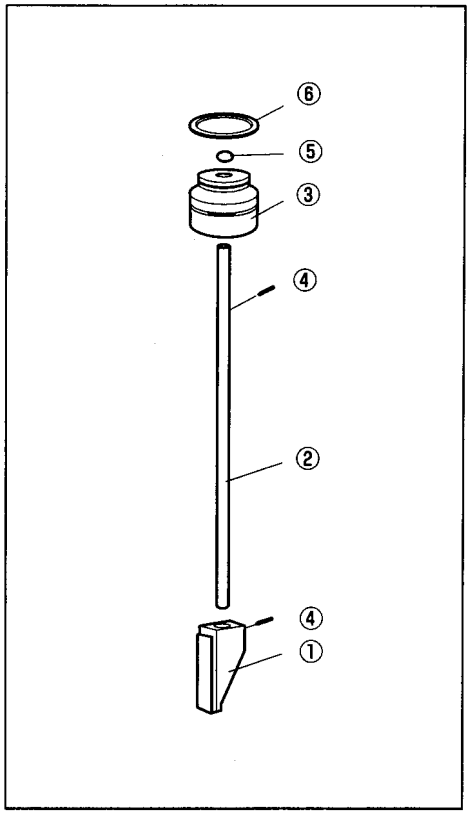
Clutchpinsnaprings Replacewithnewone.

Special Tool	Clutchpin snaptool
	345-72229-0

AssemblingClutch Cam, CamRodand ClutchCamRodBushing

Installthefollowingcomponents.

①Clutchcam
②Clutchcamrod
③Camrodbushing
④Clutchcamspringpin:3-12
⑤0-ring:2.4to5.8
⑥ 0-ring:3.5to21.7



Special Tool	SpringpintoolB
	345-72228-0

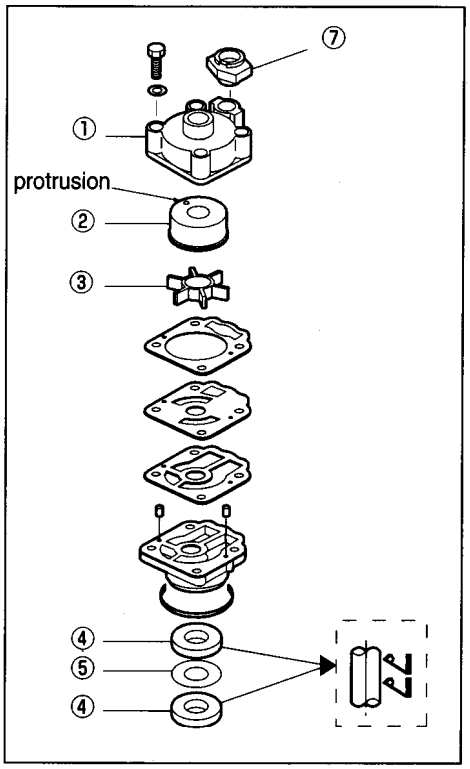
Springpinsmustneverbereused.Applygearoiltothe0-rings.
Installsothatthespringpindoesnotprotrudeoutfromtheclutch cam

Installthefollowingcomponentsonthegearcase.
①Camrodassembly
② Camrodbushingstopper

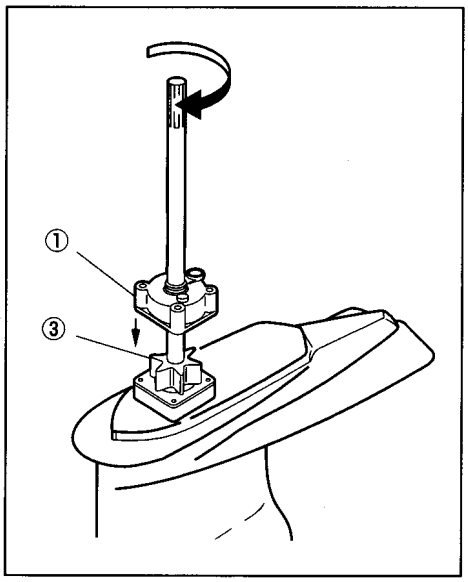
Onceinstallationiscompleted,operatethecamrodtoconfirmthatitmoves freelyupanddown

AssemblingWater Pump

Installthefollowingcomponents.Refertosection7(InspectingCoolingSystem)ofChapter3(Inspection andMaintenance)fordetaileddescriptionsofcomponents.



- Confirmoilseals④arefacingrightsideup.
- Besuretoinsertshim⑤betweentheoilseals
- ④.
- Whiletakingcarenottoscratchthelipareaoftheoilseals④,insertthedriveshaftintothepumpcase.
- Carefullyfittheprotrudingsideofthepumpcaseliner②intotherecessionintheupperpump case①.
- Insertthepumpimpellerkey firmlyontothedriveshaft.
- ApplyOBMgreaseinthepumpcaseliner ②.
- Wheninstallingthepumpimpeller ③intheupperpumpcase①,dosobyrotatingthedriveshaftasshownintheboottomfiguretotheright. (Make surethatthepumpimpeller③bladesarefacingrightsideup.)



Adding Gear oil

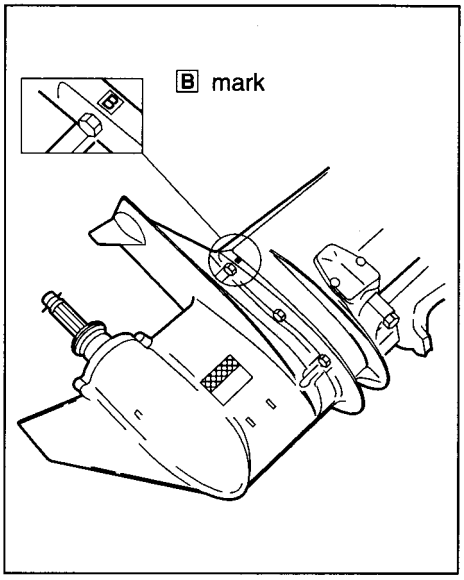
Refer to section 5 (Inspecting Gear Case Area) of Chapter 3 (Inspection and Maintenance)for detailed description of gear oil replacement procedure.

Assembling Gear Case Assembly

• Apply a thin coating of the specified rease to the spline area on the engine side of the drive shaft.
Grease Type: LT-2

Install water pipe by first applying oil to the water pipe seal rubber and sliding it through the rubber seal.

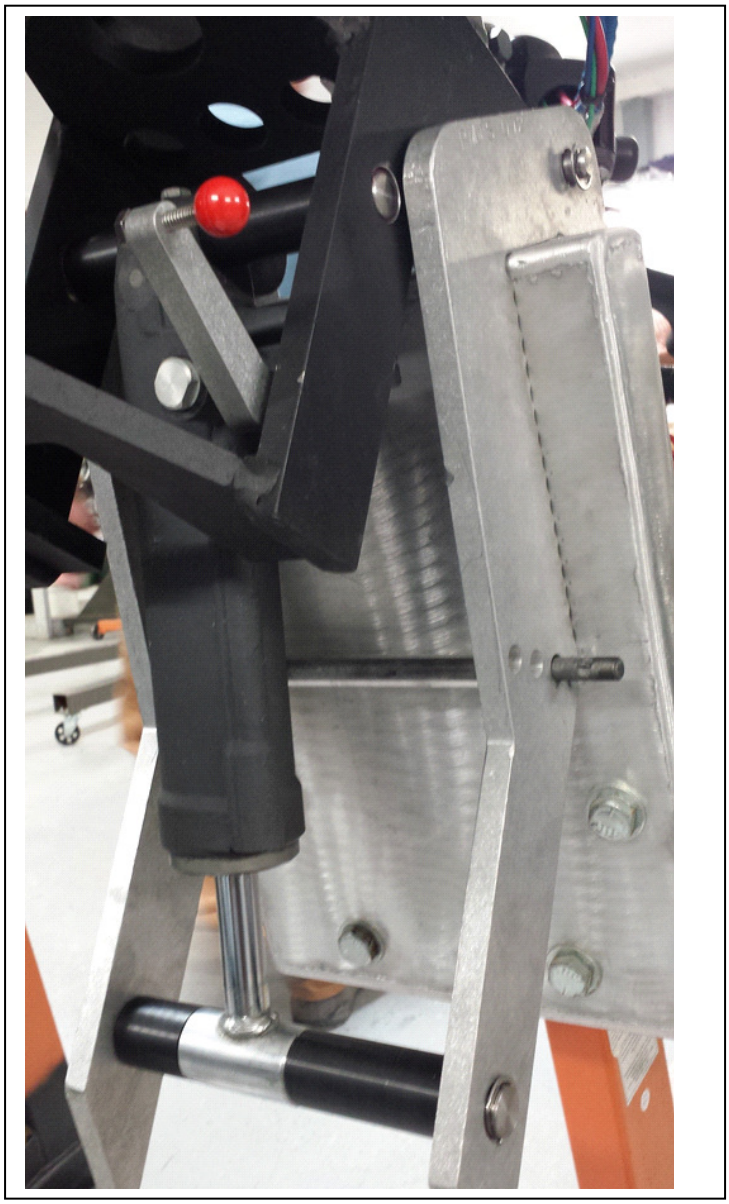
Assemble by first installing bolts at the 2 locations on the gear case marked with the[B] then install the remaining bolts.



Torque:19 to 21N-m:1.9to2.1kg-m:14to15lb-ft

Spring pin ⟶ Replace with new one.

Special Tool	Spring pin toolB
	345-72228-0



Chapter 7 Trim and Tilt

7

Overview

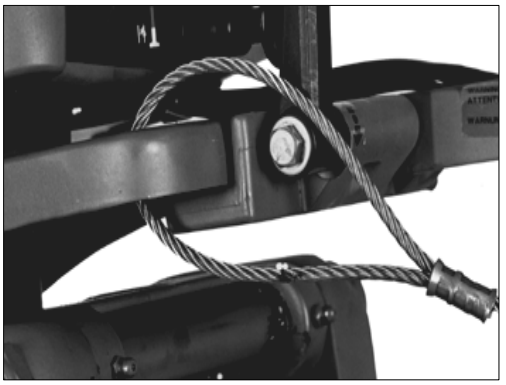
The Raider has a uniquely designed transom mount that allows the operator easier mounting of the outboard on the Rubber Inflatable Boats. The design allows the motor to be slid over the transom and mounted even in high sea states. This mount is lightweight and robust built for the Warfighter.

1. Motor Operating Instructions

a)Motor Tilt Lock:

1) Allow motor to drop to running position (against stop pin in transom bracket) before lifting Lock down Lever.
2) Motor is easier to install onto transom when tilt is locked down.
3) Tighten clamp screws by hand. DO NOT use tools to tighten clamp screws.

- To prevent loss of engine overboard, attach engine retention cable to RIB.



Retighten engine clamp screws after 15 minutes of operation.
Check clamp screws on a regular basis.

b) **Pull Start Assembly**

The Raider uses a robust pull starter made completely of machined parts. We have eliminated the cable assembly from the pull starter to the shifter to minimize corrosion. Conventional cable assemblies that connected the pull starter to the shifter, over time corroded and became an issue. This function is inside the Electronic Control unit for both safety and reliability. Eliminating this cable besides eliminates corrosion issues (using less parts) supporting higher reliability.

c) **Starting Procedure**

1. Move the tilt/run lever to RUN position.
2. Place engine in normal operating position.
3. Remove the "fuel connector protection cap" and connect the fuel line connector from the tank to the engine's fuel connector.
4. Snap fuel line connector onto bladder or fuel tank connector.
5. Squeeze fuel line primer bulb until firm.
   - If the fuel tank has a manual vent, open it. If you don't, the engine will eventually die from fuel starvation)
6. Attach the clip and lanyard assembly to emergency stop switch.
   - To start engine, clip must be installed.
   - Attach lanyard to secure place on your clothing.
7. Turn twist grip to full closed throttle position.
8. Move shift lever to the NEUTRAL position. The engine will ONLY start in NEUTRAL.
9. Pull starter handle slowly until starter engages, then pull forcibly for a full rope pull. Maintain fuel pressure by squeezing primer bulb until engine is running continuously.

2. After RAIDER is started

a) **Check the water pump indicator.** A steady stream of water indicates the water pump is working.

> If the water pump indicator is not discharging a steady stream of water, STOP the engine when it is safe. Refer to Overheating in this section.

b) **Idle Speed:** Idle speed is controlled by the Electronics Control Unit (ECU) and is not adjustable.

c) **Throttle Friction:** To increase throttle friction, turn the throttle friction screw clockwise. To decrease friction, turn the throttle friction screw counterclockwise. DO NOT over tighten.

d) **Shifting:**To avoid gear case damage:DO NOT attempt to shift engine from NEUTRAL to FORWARD or REVERSE when the engine is NOT running. Clutch dogs can align lug-on-lug and result in shift linkage and lower gear case parts damage.

> When shifting, always wait until boat has slowed and engine is at idle speed.

1. **Shift to FORWARD**: After engine is running smoothly, turn throttle control to SHIFT position or slower. Move shift lever to FORWARD with a firm, quick motion.

> *** DO NOT shift engine with throttle control advanced beyond the shift position..**

2.**Increase Speed:**Turn throttle control counterclockwise toward FAST (toward you if seated in boat next to engine).

3. **Decrease Speed:**Turn throttlecontrol clockwise toward SLOW (away from you if seated in boat next to engine).

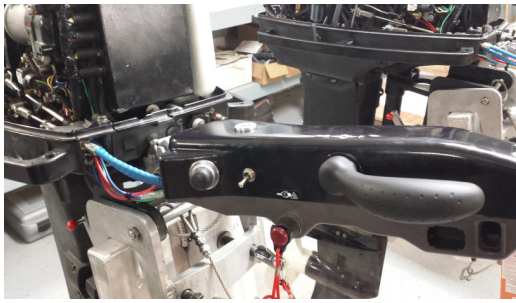
4. **Shift to NEUTRAL:** Turn throttle control clockwise to the SHIFT position or slower. Move the shift lever to NEUTRAL with a firm, quick motion.

> When shifting, always wait until boat has slowed and engine is at idle speed.

5. **Shift to REVERSE:** Turn throttle control clockwise to the SHIFT position or slower. Move shift lever to REVERSE with a firm, quick motion.

> When in REVERSE, operate with additional care as the engine has no impact protection if it hits an underwater obstruction.

* Do not operate engine in REVERSE with the tilt/run lever in TILT. Engine may tilt out of the water, resulting in loss of control.



3. Stopping RAIDER

1. Slow engine to idle speed.
2. Move shift lever to NEUTRAL position.
3. Press and hold stop button until the engine stops running.

a) **Trim Angle** Engine should be perpendicular to water when boat is underway. This adjustment can only be determined by water testing the boat. Set angle adjustment for NORMAL RIB load.

- Move angle adjusting rod as required.

b) **Trailering** Place the engine in the normal vertical position. For additional road clearance, move angle adjusting rod to an outer stern bracket position. Refer to RAIDER Trim Angle.

- **DO NOT** use the tilt support as a tailoring bracket.

c) **Tilting :**DO NOT push down on tiller handle to tilt engine.

d) **Raise RAIDER**

1. Move tilt/run lever to the TILT position.
2. Use tilt grip on engine cover to raise engine to the full tilt position. Tilt support will automatically engage.

While engine is tilted, leave tilt/run lever at TILT position. If lever is at RUN position, the tilt support can release unexpectedly and allow engine to drop.

e) **Lower RAIDER**

1. Move tilt/run lever to RUN position.
2. Use tilt grip on engine cover and raise engine slightly to disengage tilt support. Lower engine into RUN position.

f) **Shallow Water Drive** The engine's shallow water drive position is controlled by the position of the angle adjusting lever. The Raider features a shallow water drive system that allows for multiple positions for shallow water drive. As the RIB with loads can vary we have made the shallow water drive "adjustable" not in one fixed position like commercial outboards.

g) **Engage Shallow Water Drive**

1. Move tilt/run lever to TILT position.
2. Use tilt grip on engine cover to raise the engine to your selected position.
3. Lock the engagement lever.

h) **Shallow Water Operation**

DO NOT operate engine with gear case dragging on sea bottom. This can result in propeller or water pump damage.

1. Place engine in shallow water drive position.

Refer to **Shallow Water Drive.**

DO NOT operate engine in REVERSE with the tilt/run lever in the TILT position. Engine can tilt up resulting in loss of control.

2. Run at SLOW SPEEDS ONLY. Check water pump indicator often.
3. Before operating in deep water, be sure to lower engine and move tilt/run lever to the RUN position.

Engine does not have impact protection when operated in the shallow water drive position or when the tilt/run lever is in the TILT position. Engine will tilt up suddenly if it hits an underwater obstruction.

i) **Impact Damage :**Your RIB and engine can be seriously damaged by a collision at high or low speeds.

If you hit an object, stop immediately and examine the engine for loose mounting hardware or clamp screws. Inspect for damage to stern and swivel brackets, and components in the area of impact. Also, examine the RIB for damage. Tighten any loose hardware. If collision occurred in the water, proceed slowly to shore. Before operating again, inspect all components.

Failure to inspect for damage can result in sudden, unexpected component failure and loss of control. Uncorrected damage can adversely affect the RIB and engine's ability to resist subsequent collisions.

j) **Special Operating Conditions**

1. Sea Water
2. Fresh water flushing is recommended after use in salt, polluted, or brackish water to prevent deposits from clogging the cooling passages.

- Check gear case anodes for deterioration, and replace if necessary.

During long periods of non-use, tilt engine so that the gear case is out of the water, unless the temperature is below 32° F (0° C). When removing engine from water, allow cooling system to drain completely by placing engine in upright position.

k) **Weedy Water:** Weeds can block the water intakes and cause engine to overheat. Weeds on the propeller will cause engine to vibrate.

Run at slow speeds and reverse engine frequently to clear weeds from propeller. Check water pump indicator often. Remove weeds from propeller and water intakes before operating in clear water.

l) **Freezing Weather:** To avoid engine damage, keep the gear case submerged in the water at all times. Before operating in freezing temperatures, check gear case lubricant. If leakage is found, gear case seals will need service. Refer to Section 8, Gear case.

When removing engine from water, keep the engine in an upright position until the cooling system is completely drained.

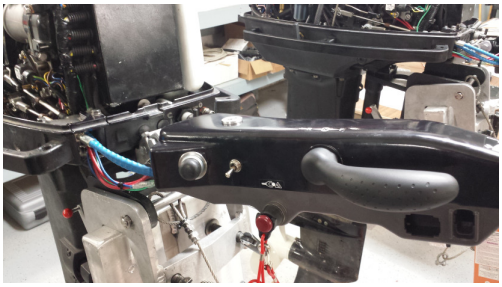
- Water that leaks into gear case or is left in the cooling system can freeze when the engine is removed from the water. This can cause serious damage.

4..Overheating

- **DO NOT** operate engine out of water even momentarily.
- The engine's Water Temperature sensor is NOT a warning device it has been silenced for mission effectiveness.
- The RAIDER does not have the normal overheat warning sounding device.
- The RAIDER will not initiate a warning to prevent powerhead damage.
- If you suspect the engine is overheating or has overheated, STOP the engine **only when it is safe**.
- When operating the engine, the water intakes must be completely submerged. **Make sure the water intake screens are not installed upside down** (ramps must be forward). If upside down, the engine will overheat. Observe proper transom height and engine trim angle.
- When engine is running, the water pump must be discharging a steady stream of water. Check often, particularly when operating in weeds, mud, or debris laden water, or at an extreme engine angle.
- **IF** the water pump stops or becomes intermittent, reduce engine speed to an idle when it is safe. Shift engine into REVERSE and operate at a slow speed for about 10 seconds. This might clear debris blocking the water intake screens.
- **IF** the water pump indicator is still **not discharging** a steady stream of water, **SHUT OFF** the engine when it is safe. Clean the water intake screens and water pump indicator. Restart the engine and run at idle.
- **IF** the water pump still does not discharge a steady stream of water, **SHUT OFF** the engine when it is safe. **DO NOT** attempt to operate engine. Refer to **Section 8, Gear case, Water Pump Assembly.**

5. Emergency Starting

- Make sure the shift lever is at NEUTRAL to prevent sudden boat movement when the engine starts.



The Raider has three starting modes.

1. **Battery Start** - the battery located under cowling, this is the primary starting mode. If the battery is dead use the conventional pull start..The battery will recharge very quickly.
2. **Pull Start**- The secondary starting method is the Raider. If your motor does not come with a battery this option is the primary starting method. The pull start has been designed for rough use and should not fail. The most frequent failure is rope failure or weapon fire that might affect the pull start. * In event of damage proceed to step 3.
3. **Emergency Pull Start** -
    a) Remove Cowling by unlatching the cowling.
    b) Open the Basic Issue Items kit. A special service tool (wrench) is contained that fits the bolts holding the pull starter to the flywheel.
    c) Remove bolts and the starter can be removed.
    d) Lift starter assembly from Raider engine.

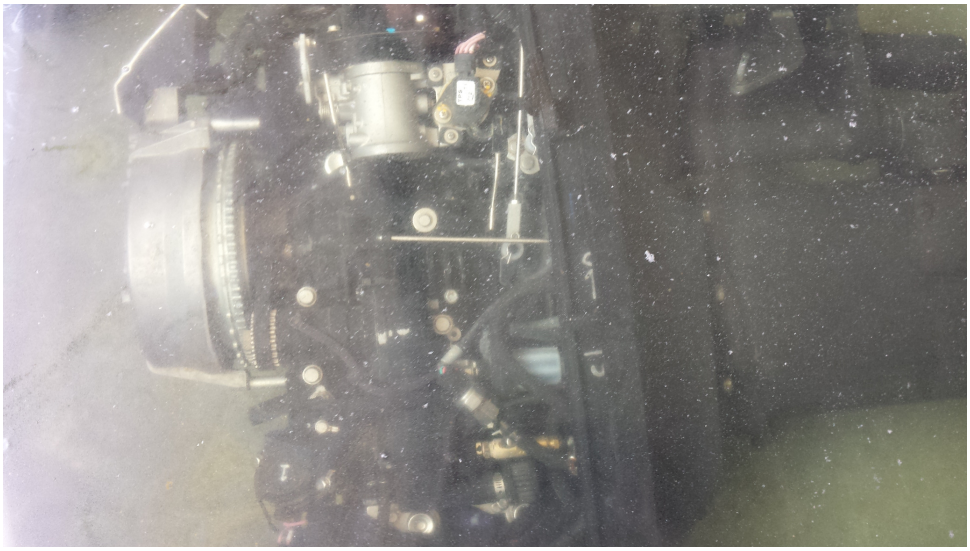
* If starter cord is broken, it might not be long enough to use as an emergency starter cord. If intact, cut cord from starter assembly, tie knot in the end. If this rope is inadequate you will find in the Basic Issue Items (BII) is a rope. Tie a knot in the end of the rope, Insert the knot end of rope into the flywheel notch; wrap rope around flywheel clockwise; tighten rope until pressure is felt, pull hard on the wooden handle with a quick solid motion to start the Raider.

Note:

You can open the dewatering unit for a first pull to insure the motor turns over freely. The dewatering valves will act as a compression release. Close dewatering valve to start after determining the outboard pulls over freely. After starting replace engine cover; put aside the pull starter for further maintenance.

Engine cover: This is a machinery guard.

- Prevent injury by keeping hands, clothing, and hair clear of all moving parts.
- DO NOT use your hands to turn the flywheel;
- use recoil starter or emergency rope only.



Raider underwater for 24 hours

6.Pre-Submersion Procedure

The Raider has been designed for submersion. Insure dewatering valves are closed.

- Insure the oil tank is complete filled.

- **Dewatering is discussed in Chapter 9.**

Chapter 8 Tiller Handle Type

8

1. Tiller Handle, Shifter and Emergency Stop

The Raider Tiller Handle, shifter and emergency stop is designed as one unit with the capability of each to be serviced independently.

- The unit is ergonomically designed for the outboard operator.
- The tiller handle is robust and can be used to tilt the outboard forward into the RIB using only the tiller handle, however, it is recommended the operator also use the rear cowling slot to assist during normal tilting.
- The length of tiller handle is designed to fold up next to the cowling for compactness and stowage during transport.
- The Raider outboard tilting implemented an assist cylinder which allows the operator to use minimum force for the tilting. The system is robust to allow the operator to tilt the Raider outboard into the RIB for dewatering or beaching very quickly during the mission.

The tiller arm has been designed to allow operation of two outboards on the same RIB. Another assembly, called the Dual Motor Control and Throttle (DMCT) allows a single operator to control a dual configuration outboard motors on the same RIB. This system has a direct connection to both motors for positive throttle response and steering.

Trim/Tilt

The trim and tilt function is accomplished via a red knob and a hydraulic assist trim/tilt cylinder attached from the transom mount to the Raider outboard. By pulling the red knob located on the transom the motor can be placed in any position. It is easily tiled with the sealed hydraulic cylinder located between the transom and the motor.

The tiller handle incorporates an emergency stop switch that cuts all power to the RIB. The stop switch is activated when a lanyard is pulled and removes a clip or when depressed. The lanyard is clipped to the operators clothing prior to starting the Raider.An extra emergency restart clip is provided in the BII.

Attached to the tiller handle is a shift lever designed for easy and positive shifting by the operator. The shift lever is large enough for operation with gloves and firm enough to feel a positive lock when it is shifted from forward to neutral and neutral to reverse. The motor will not start if the shift lever is in forward position. The tiller handle can be adjusted for the operator to different positions.

Allows for tight turns

CAUTION:
The motor will start if the shift lever is in reverse.

throttle-friction lock: After a speed is selected this option minimizes the workload on operator over long duration missions.

operate throttle friction lock:

- **To increase throttle friction** by turning the throttle friction setting clockwise.
- **decrease throttle friction:** to operate the throttle manually, turn the throttle friction setting counterclockwise.

* Do not Over tighen

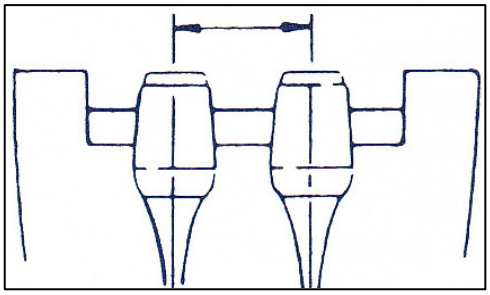
Increase Speed: Turn throttle control counterclockwise toward FAST (toward you if seated in boat next to engine). To

Decrease Speed: Turn throttle control clockwise toward SLOW (away from you if seated in boat next to engine).

Shifting: Always shift when the outboard is at idle speed

Stop :slow engine to idle speed then shift lever to NEUTRAL position and press and hold stop button until the engine stops running.

avoid gear case damage, by not shifting from neutral to forward or reverse when the engine is NOT running as it could cause damage in the lower gear case.



Emergency Stop

The emergency stop is activated by removal of the special clip attached to a lanyard or the emergency stop button is depressed by the operator.

Dual Motor Control and Throttle (DMCT)

The Raider was designed and developed as a two motor configuration. The dual outboards are spaced apart between 18 and 26 inches. The twin engine steering and speed assembly has been designed for the soldier. The dual motor assembly simply slides over the existing tiller handles with no modifications to the tiller handle. No special tools are required to install the dual motor assembly.

The DMCT is designed to link up the dual configuration Raider Outboards with ease

Advantages of the Raider DMCT design:

- features a one-motor kick up feature in case only one of the motors hits a below water obstacle;
- ease of connection even if the motors are not precisely placed on the I-CAC; the extended handle will fold up if both engines are beached without harming the RIB.
- also features vibration isolators with automatic adjustment when making turns

Chapter 9 **Dewatering**

9

The Raider outboard is a submersible engine.

Due to the extreme operating conditions this engine may experience during combat, Raider has incorporated three vales that open drains: crankcase, cylinders and air/fuel drain systems to allow the engine to be de-watered.

This de-watering system will allow the operator to quickly remove water from inside the engine, restart the engine, and operate the boat to complete the search and rescue mission.

Once this outboard has been submerged in fresh or salt water, it must be dewatered and started immediately attached to the RIB.

Immediate service can minimize the corrosive affect that air has on the polished surfaces of the crankshaft, connecting rods, and internal powerhead bearings.

Look down from back/top of Raider

IMPORTANT: If the outboard cannot be started or serviced immediately, it should be resubmerged in fresh water to avoid exposure to the atmosphere.

Raider has develop this de-water procedure to quickly purge the engine of water and to lubricate the critical components of the engine. This will allow the operator to return the Raider to normal operation without damage to the engine. Extended submersion, particularly in salt water, in addition to the above, could result in corrosion of internal components such as piston rings, cylinder sleeves, and other bearings. The Raider contains a patented dewatering system made specifically to eliminate water from the Raider outboard after submersion. The dewatering system uses a system of valves located at specific locations that can be opened to allow the water to escape.

1. Location of three dewatering Valves the operator must open after submersion.

Rear dewatering valve: Combustion chamber dewatering valve/compression release.

Three valves are located in each cylinder head connected to a single unit. The valves are opened when the operator reaches in the back of the cowling where a knob is located and turns the valve counterclockwise, which opens the three cylinder dewatering valves. These valves, when opened, allows any water located between the piston and head to be forced out when the pull starter is engaged. These valves have been designed to allow the maximum amount of water to be eliminated in the shortest pull cycle. These valves insure no “hydro-lock” occurs – which is water caught between the piston and the cylinder head.

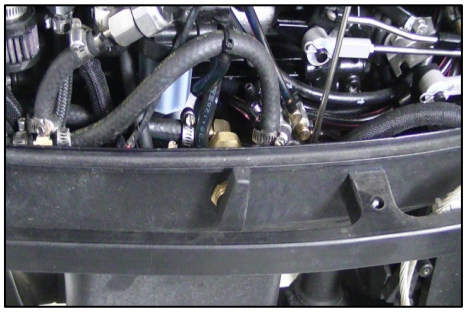
The dewatering valve also acts like a compression release if the Warfighter want to turn over the engine easily to insure everything appears to be in order. This compression relieves works well in a cold environment. After a few pulls with the dewatering valves open, simply close the valves to start the engine.

Front dewatering valve.Crankcase dewatering valve.
This valve is turned counterclockwise to open. When the Raider outboard is tilted into the RIB this allows the water to drain from the crankshaft. The water will automatically run out when tilted into the RIB and turned sideways. When a short pull to the pull start has been completed, the water has been egressed.

Mid-Valve.Compressor/ fuel rail dewatering valve is located on the left hand side of the motor as the operator faces the motor from inside the RIB. This valve is turned counterclockwise to allow the water to drain from the air and fuel system.

The Raider outboard dewatering process is as follows:
Reach and open rear dewatering valve.
Tilt the Raider into a horizontal position into the I-CRC or I-CAC. Turn the front valve to counterclockwise to open.
Turn the Mid-Valve in a counterclockwise motion to open.

3. Open the mid drain valve ¼ turn counterclockwise (left)

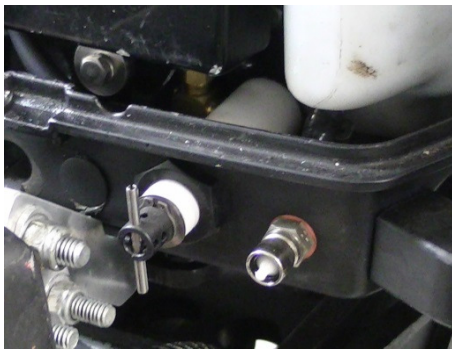


Front port side in pan
Vertically closed

2. De-Watering Procedure

Place shift lever in NEUTRAL and remove emergency stop clip and lanyard.
Twist throttle grip to idle Throttle position.

1. Turn the drain valve on right front of motor ¼ turn counterclockwise (left)
2. Turn the rear drain valve on the back of the cowling ¼ turn counterclockwise (left)



4. Tilt the outboard to full tilt position into the RIB; and turn so the drain valves are on the lowest side.
5. Allow the water from the front valve drain out.
6. Pull starter handle slowly until starter engages. Continue pulling with firm pressure to force water out of the engine as water is ejected with slow, light pulls from the pull starter. Continue until no more water is ejected.
7. Close the three valve ports in a clockwise rotation.
8. Two pulses on the rubber fuel ball inject new fuel into the Raider.

CAUTION

To avoid outboard falling during de-water procedure, tilt/run lever MUST remain in the TILT position. When the engine begins to turn freely, pull an additional four times. This will help drain water that might be trapped in the cylinders.

9. Tilt outboard to the normal running position.
10. Replace emergency stop clip and lanyard.
11. Squeeze primer bulb several times until definite resistance is felt.
12. With twist grip in the ¼-throttle position, pull starter handle to start engine.
13. After engine has run at IDLE speed for 30-60 seconds, turn drain valves to the RUN position.

IMPORTANT:

DO NOT run the outboard with the drain valves in the DRAIN position more than 3 minutes. Engine damage can result.

Continue to run under normal operating conditions (RIB on plane) for at least 30 minutes (2500 RPM or above).

IMPORTANT:

You MUST run the outboard after the dewater procedure to dry out internal moisture.

The operator does not need to remove the cowling to dewater the Raider. The Raider should start within two/three pulls after the dewatering valves are closed.

If your Raider has the internal lead acid battery under the cowling; simply open the dewatering valves; tilt the motor into the Rib; press the starter button on the pan for a few seconds. After a few seconds close the valves, press the rubber fuel ball to inject new fuel; and push the start button. The motor will start immediately.

After Submersion- Summary

After submersion or after a mission, the Raider outboard must be prepared to be returned to non-use or prepared for your next mission.

If the Raider has been submersed during your mission and it cannot be serviced, keep it submersed until it can be serviced to avoid prolonged exposure to the atmosphere, keep it submerse in fresh water, but get it prepared for your next mission as soon as possible.

- Dewater the engine following the procedures in **Dewater Procedure**.
- Operate the engine for approximately five minutes at full operating temperature with fresh water.
- Whenever possible after use or submersion in seawater, wash entire engine and powerhead with fresh water to remove salt deposits, especially under the flywheel where the accumulation of deposits will build up. Wipe down with a dry cloth.
- Spray the entire powerhead with a liberal coat of Anti-Corrosion Spray penetrate/lubricant or equivalent.
- Spray Penetrating Lubricant or equivalent under the flywheel.
- Leave the cowling off, if possible, to allow the powerhead and other components to air dry.

Chapter 10 Troubleshooting

1. Troubleshooting Table

Thissectionontroubleshootingcoversthevariousmalfunctionsandfailuresthatcanoccurintheengine'selectricalcomponents.Notificationofmalfunctionsandfailuresisprovidedusingasystemofwarningbeep(buzzer)andindicatorlights. The Raider is prepared for a mission prior to placing on the RIB. The outboard is designed that only two of the three cylinders need to work to get home. The key parameter the operator must continually visually checking is to insure water is being continually coming from the outboard.

This Raider Outboard has silenced all alarms to avoid mission compromise. The signals and warnings are recorded in the Electronics Control Unit that can be downloaded at the maintenance shop. The Raider on the mission should have fuel and oil reserve full. Emergency get home support is found in the BII kit.

	Item		Self-diagnosable points	Beeps Disabled	Warning Disabled 	Warning Disabled 	Warning Disabled 
1. Starter motor dead Or turns very slowly Only on Raiders when ordered	1-1.	Gearshift					
	1-2.	Battery	O				Flashing
	1-3.	Fuse					
	1-4.	Wiring					
	1-5.	Electrical components					
2. Engine turns over but won't start	2-1. Powerhead	Insufficient compression					
	2-2. Fuel system	Bladder/Fuel tank					
		Low fuel pressure in air rail [standard:600to640kPa] 87to 93 psi					
			O		Flashing	Flashing	Flashing

Cause		Remedy(See chapter one)Servicing Information for specs.)
1-1-1.	Gear shift in forward or reverse position.	Shift to neutral position.
1-2-1.	Battery low; or battery cables or circuit line connections maybe loose or corroded.	Recharge or replace battery. Check battery terminal and cable condition.
1-3-1.	No Fuse in Raider Configuration	Maintenance shop repair.
1-4-1.	Severed wire or loose connection.	
1-5-1.	Faulty main switch, neutral switch, starter solenoid or starter motor.	Inspect and replace as necessary.
2-1-1.	Stuck piston ring.	Inspect and repair or replace as necessary.
2-1-2.	Reed valve fails to close,is worn or damaged.	
2-2-1.	Fuel is lowor empty in tank or bladder	Replenish fuel and perform step 2-2-3.
2-2-2.	Air vent is closed.	Open air vent and perform step 2-2-3.
2-2-3.	Fuel not coming to fuellines.	Check primer valve for stiffness. Pinch primer valve, when it stiffens turn main switch ON for 2 seconds. Repeat until primer valve is sufficiently stiff.
2-2-4.	Fuel not fed to fuel lines after tank is filled.	
2-2-5.	Fuel filter is clogged.	Inspect fuel tank, RIB bladder and engine fuel filters and clean and replace as necessary.
2-2-6.	Water in fuel filter.(Indicated by floating of red float.)	
2-2-7.	Air pressure too low in airrail.	Refertostep2-3.
2-2-8.	Clogged fuel lines.	Check for twisted, flattened or bent fuel lines.
2-2-9.	Trim/Tilt does not function.	Confirm no mechanical damage has occurred.
2-2-10.	Components damaged.	Replace components.
2-2-11.	Internal leak in hydraulic tiller case.	Replace hydraulic unit.

Symptom	Item		Self-diagnosable points	Beeps Disabled	Warning indicator Disabled 	Warning indicator Disabled 	Warning Battery Disabled 
2. Engine turns over but won't start	2-2. Fuel system	Low fuel pressure in airrail [normal:600to640kPa]					
		High fuel pressure in airrail [standard:600to 640kPa]87to93psi					
	2-3. Airsystem	Low air pressure in airrail [standard:530to570kPa]77to83psi					
		High air pressure in airrail [standard:530to570kPa](77-83psi)					
	2-4. Electrical system	Fuse					
		Stop switch					
		Air injector					
		Sparkplug[Gapstandard0.7-0.Bmm(0.0276-0.0315in)]					

Cause		Remedy (See chapter one Servicing Information for specs.)
2-2-12.	Fuel regulator leakage.	Replace.
2-2-13.	Fuel leakage.	Inspect piping and connectors for damage.
2-2-14.	Return circuit from fuel regulator outlet to Vapor separator is clogged.	Inspect and repair.
2-2-15.	Faulty fuel regulator.	Replace.
2-2-16.	High air pressure in airrail.	Refer to steps 2-3-9 and 2-3-10.
2-3-1.	Loose nut on airhose connector.	Inspect and repair as necessary.
2-3-2.	Air filter is clogged.	Inspect and replace as necessary.
2-3-3.	Orifice is clogged.	Inspect and replace as necessary.
2-3-4.	Worn or damaged 0-rings on air hose connector.	Inspect and repair as necessary.
2-3-5.	Collapsed air hose path.	
2-3-6.	Air regulator leakage.	Replace.
2-3-7.	Damaged reed valve in air compressor.	Inspect and replace as necessary.
2-3-8.	Worn cylinder or piston ring in air Compressor.	
2-3-9.	Faulty air regulator.	Replace.
2-3-10.	Path down stream from air regulator is Clogged.	Inspect and repair as necessary.
2-4-1.	Burnt out fuse.	Inspect for cause off use burn out (overload), and repair and replace fuse.
2-4-2.	Malfunctioning lock.	Inspect.
2-4-3.	Short circuit in stop switch.	Inspect and repair as necessary.
2-4-4.	Carbon buildup or damage to fuel injector.	Connect operational injector to each harness and confirm that injector generates clicking sound of normal operation when engine is turned over. Clean and replace as necessary.
2-4-5.	Faulty spark plugs.	Repair gap to specifications.Replace If electrodes are excessively worn, cracked or damaged. Replace incases of leakage or blackened electrodes due to carbon buildup. Replace if wet with fuel.

Symptom	Item		Self-diagnosable points	Beeps Disabled	Warning indicator Disabled	Warning indicator Disabled	Warning (battery) Disabled
2. Engine turns over but does not start	4.Electricalsystem	Spark plug cap.					
		Crank position sensor.					
		ECU					
		Self-diagnosing function indicates low (abnormal) Battery voltage.	O				Flashing
		Self-diagnosing function Indicates faulty components.	O				
		Self-diagnosing function indicates TPS idling position error.	O		Flashing	Flashing	Flashing
			O				
3. Engine starts but idling falters or is unstable	1.Powerhead	Engine rpm abnormally low (seized up).					
		Low compression.					
	2.Fuelsystem	Fuel tank.					
		Fuel filter.					
		Low fuel pressure in airrail [normal:0.6to0.64MPa]87to93psi					

Cause		Remedy (See chapter on Servicing Information for specs.)
2-4-6.	Loose cap.	Inspect.
2-4-7.	Faulty cap.	Replace.
2-4-8.	Incorrect gap with encoder (flywheel).	Inspect and adjust.
2-4-9.	ECU not functioning.	Replace ECU.
2-4-10.	Battery low or less than 1OV during turn over due to faulty starter motor voltage.	Recharge or replace battery.Check condition of cables and terminals. Inspect starter motor condition.
2-4-11.	Faulty components, connections or severed line in harness.	Inspect, repair and replace as necessary.(Refer to 9-20)
2-4-12.	TPS initial values incorrect.	Inspect and repair ; then reset TPS. (*2)
2-4-13.	TPS (*1)and 0<ECU have been replaced.	Reset TPS.(*2)
3-1-1.	Scratched piston or other factor causing increased resistance.	Inspect and repair.
3-1-2.	Piston rings stuck.	
3-1-3.	Reed valve fails to close, is worn or damaged.	
3-1-4.	Faulty cylinder head or engine base gasket.	
3-1-5.	Loose head bolts or crank case bolts.	
3-2-1.	Fuel is low or empty in tank.	Refer to step2-2-1.
3-2-2.	Air vent is clogged.	Refer to step2-2-2.
3-2-3.	Water in fuel filter.	Inspect fuel tank, boat and engine fuel filters and clean and replace as necessary.
3-2-4.	Fuel filter is clogged.	
3-2-5.	Fuel lines are clogged.	Check for twisted, flattened or bent fuel lines.
3-2-6.	Lift pump(*1) not functioning.	Inspect, repair and replace as necessary.
3-2-7.	Leakin FFP(*1) case.	Refer to step 2-2-11.

*1.TPS: abbreviation for throttle position sensor.

FFP: abbreviation for fuel-feed pump (electric pump)

Lift pump :diaphragm type fuel pump.

*2.TPS reset: TPS reset required under following conditions.

① Indicates occurrence of TPS error due to remote control cable setup.Read just cable.

② Indicates that TPS and/or ECU have been replaced.

③ Indicates that the link or rod snap ring is replaced due to warpage or wear in linkage.

Refer to the section on self-diagnosis functions and reset the TPS to its initial values.

Symptom	Item		Self-diagnosablepoints	Beeps Disabled	Warningindicator(oil) Disabled 	Warningindicator8 (watertempDosab;ed 	Warning(battery) Disabled 
3. Enginestartsbutidling faltersorisunstable	3-2. Fuelsystem	Lowfuelpressureinairrail.[standard:600to640MPa]87to93psi					
		Highfuelpressureinairrail.[standard:600to640kPa]					
	3-3. Airsystem	Lowairpressureinairrail.[standard:530to570kPa]					
		Highairpressureinairrai					
	3-4.Electricalsystem	Sparkplugs					
		Sparkplugcaps					
		Self-diagnosingfunctionindicatesfaulty components.	O				
		Self-diagnosing functionindicatesfaultyTPSidling position.	O		Flashing	Flashing	Rashing
			O				
		Airinjector					
4. Engineidlestoohigh	4-1.Electricalsystem	Variableidlingswitch					
		Self-diagnosing functionindicatesfaultyTPSidlingposition.	O		Flashing	Flashing	Flashing
			O		Flashing	Flashing	Flashing
5. Engineunstable above3,000rpm	5-1.	Sparkplugs					
	5-2.	Enginerpmcontrol					
	5-3.	FuelpressureorairPressuretoolow.					
	5-4.	TPS(*1)notfunctioning.	O		Flashing	Flashing	Rashing
6. Noaccelerationatfullthrottle	6-1.Enginecompression	AdvancerarmispoorMovement.					
		Faultycompression.					

Cause		Remedy (seechapteronServicingInformationforspecs.)
3-2-8.	Fuelregulatorleakage.	Refertosteps2-2-12.
3-2-9.	Fuelleakage.	Refertostep2-2-13.
3-2-10.	Lowcompressioninairrail.	Refertostep2-3.
3-2-11.	Faultyfuelregulator.	Replace.
3-2-12.	Returncircuitfrom fuel regulatoroutlettovaporseparatorisclogged.	Inspectandrepair.
3-3-1.		Refertostep2-3.
3-3-2.		
3-4-1.		Refertostep2-4-3.
3-4-2.	Loosecap.	Inspect.
3-4-3.	Faultycap.	Replace.
3-4-4.	Faultycomponentsorconnections.	Inspect,repairandreplaceasnecessary.Refertostep2-4-11
3-4-5.	TPSinitialvaluesincorrect.	Refertostep2-4-13.
3-4-6.	TPS(*1)andforECUhavebeenreplaced.	Refertostep2-4-13.
3-4-7.	Malfunction.	Connect operationalinjectortoeachharnessandconfirmthatinjectorgeneratesclickingsoundofnormaloperationwhenengineisturnedover.Cleanandreplaceasnecessary.
4-1-1.	Idlingspeedsettingwaschanged.	Usevariableidling switchtosetidlingspeed.
4-1-2.	TPS initialvaluesincorrect.	Refertostep2-4-13.
4-1-3.	TPS(*1)and forECUhavebeenreplaced.	Refertostep2-4-13.
		Refertostep2-4-5.
		Refertostep10-1.
		Refertostep3-3
		Refertosteps2-4-12and2-4-13.
6-1-1.	Remotecontrolcablenotproperly installed.	.Inspectandreplaceasnecessary.
6-1-2.	Disfigurationorwearofthrottlelinkcomponents.	Inspectandadjust.
6-1-3.	Scratchesonpistonorcylinderliner.	Inspectandrepairasnecessary.
6-1-4.	Carbonbuildupincombustionchamber.	
6-1-5.	Excessivewearorstickingofpistonring.	

(*1)TPS:Throttlepositionsensor.

Symptom	Item		Self-diagnosablepoints	Beeps Disabled	Warningindicator A(oil) Disabled 	Warningindicator8 (watertemp)Disabled 	Warning(battery) Disabled 
6. Noaccelerationatfull throttle	6-1. Powerhead	Faultycompression					
	6-2. Airsystem	Lowairpressureinairrail					
		Highairpressureinairrail					
	6-3. Fuelsystem	Fueltank					
		FuelHose					
		Fuelfilter					
		Lowairpressureinairrail[standard: 550kPa±7%] (5.6kgf/cm^2, 80psi)					
	6-4. Electricalsystem	Sparkplugs					
		Airinjector					
		Self-diagnosingfunctionIndicatesfaulty components.	O				
7. Engineaccelerates,boatspeed doesnotincrease	7-1. Outboardengine	Propeller					
		Installation					
		Boat/RIB					
		Stopswitch					
		Groundline					

Cause		Remedy (SeechapteronServicingInformationforspecs.)
6-1-6.	Faultyoilsealoncrankcase.	Inspectandrepairasnecessary.
6-2-1.		Refertostep2-3.
6-3-1.	Fuelisloworemptyintank.	Refertostep2-2-1.
6-3-2.	Airventisclogged.	Refertostep2-2-2.
6-3-3.	Airbeingsuckedinthroughcracks orfaultyconnectors.	Inspectandrepairasnecessary.
6-3-4.	Waterinfuelfilter.	Inspectandcleanasnecessary.
6-3-5.	Fuelfilterisclogged.	Inspectfueltank,boatandenginefuelfiltersandcleanandreplaceasnecessary.
6-3-6.	Fuellinesareclogged.	Checkfortwisted,flattenedorbentfuellines.
6-3-7.	Liftpump(*1)notfunctioning.	Inspect,repairandreplaceasnecessary.
6-3-8.	Leak inFFP(*1)case.	Inspectrubbersealoninternalcomponentsandinspectelectricfuel pump.
6-3-9.	Leakageinfuelregulator.	Replace.
6-3-10.	Fuelleakage.	Inspectlinesandconnectorsforwearanddamage.
6-3-11.	lowairpressureinairrail.	Refertostep2-3.
6-4-1.		Refertostep2-4-5.
6-4-2.	Carbonbuildupinfuelinjector.	Inspect,cleanandreplaceasnecessary.
6-4-3.	Faultyconnectionorcomponent.	Inspect,repairandreplaceasnecessary.
7-1-1.	Incorrectpropellerpitch.	Inspect,repairandreplaceasnecessary.Refertostep2-4-11
7-1-2.	Propellerisslipping.	
7-1-3.	Propelleriswarpedordamaged.	
7-1-4.	Transomlengthunsuitablefor boat.	Inspect and adjust.
7-1-5.	Incorrecttrimangle.	
7-1-6.	Boat/RIB bottomisdirty.	Inspect and clean as necessary.
7-1-7.	Incorrect loading position.	Inspect and adjust.
7-1-8.	Overloadingofboat.	
7-1-9.	Problemwithshapeofboat.	
8-1-1.	Faultyelectricalcontactonmainswitch orSeveredlineinharness.	Inspect,repairandreplaceasnecessary.
8-1-2.	Faultycontractonstopswitch or severedLineinharness.	
8-1-3.	Faultygroundlinecontactorseveredlinein Harness.	

Symptom	Item		Self-diagnosable points	Beeps Disabled	Warning indicator A (oil) Disabled 	Warning indicator 8 (watertemp) Disabled 	Warning indicator (battery)Disabled 
9. Poor acceleration at full throttle or sudden drop down to idling speed	9-1. Electrical control system	Cooling water temperature too high (temp.indicator flashes)	O	Continuous		Flashing	
			O	Continuous		Flashing	
		Battery voltage abnormally high (battery indicator flashes)	O		Flashing	Flashing	Flashing
			O		Flashing	Flashing	Flashing
		TPS not functioning	O		Flashing	Flashing	Flashing
	9-2. Remote control system	Advancer arm not functioning					
10. Unable to exceed 3000 rpm at full throttle or suddenly drops and stay sat 3000 rpm	10-1.Electrical control system	Cooling water temperature too high (temp.indicator flashes)	O	Continuous		Flashing	
			O	Continuous		Flashing	
			O	Continuous		Flashing	
			O	Continuous		Flashing	
		Battery voltage abnormally low (battery indicator flashes)	O				Flashing
			O				Flashing
			O				Flashing
			O				Flashing
			O				Flashing
		TPS not functioning	O		Flashing	Flashing	Flashing
		Remote control					

Maintenance Shop Information:

*1.TPS: abbreviation for throttle position sensor.

FFP: abbreviation for fuel-feed pump (electric pump)

Lift pump: diaphragm type fuel pump.

*2.TPSreset:TPS reset required under following conditions.

① Indicates occurrence of TPS error due to remote control cable setup.Readjust cable.

② Indicates that TPS and/or ECU have been replaced.

③ Indicates that the link or rod snap ring is replaced due to warpage or wear in linkage.

Refer to the section on self-diagnosis functions and reset theTPS to its initial values.

Cause		Remedy (See chapter on Servicing Information for specs.)
9-1-1.	Cooling water inlet is clogged.	Inspect.
9-1-2.	Faulty water pump.	Inspect, repair and replace as necessary.
9-1-3.	Faulty battery if used in Raider.	Inspect.
9-1-4.	Faulty rectifier regulator.	Inspect and replace as necessary.
9-1-5.	Faulty TPS, faulty wiring connections or Severed line in harness.	Inspect,repair and replace as necessary.
9-1-6.	Wiring connections for TPS connectors (TPS1,TPS2)are reversed.	Reconnect at proper installation location.
9-2-1.	Remote control cable unit incorrectly installed or fault in remote control box.	Inspect, repair and replace as necessary.
10-1-1.	Cooling water inlet clogged.	Inspect.
10-1-2.	Faulty water pump.	Inspect,repair and replace as necessary.
10-1-3.	Faulty thermostat.	
10-1-4.	Cooling water path clogged.	
10-1-5.	Faulty battery.	Replace.
10-1-6.	Faulty charging coil.	Inspect and replace as necessary.
10-1-7.	Faulty wiring to charging coil.	Inspect and repair as necessary.
10-1-8.	Faulty battery cables or connectors.	
10-1-9.	Faulty rectifier regulator.	Inspect and replace as necessary.
10-1-10.	Faulty TPS, faulty wiring connections or Severed line in harness.	Inspect,repair and replace as necessary.
10-1-11.	Engine was started with neutral warm-up Lever raised.	Return lever to normal position and restart.

2. TLDI – Self Diagnosing Functions

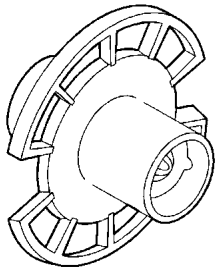
The TLDI Raider engine uses a self–diagnosing function maintain detailed information of faults that occur on missions that have been detected by the engine control unit (ECU). Special devices,such as monitoring equipment and personal computers, are required for the self-diagnosis function at the maintenance shop.

Warningindicators				ESGspeedcontrol('1)	FaultDescription	Reference	Remedy
Beeps		Centerindicator					
Continuous Intermitten t(3 short every minute) Continuous Continuous	xFlashing __________xx XxFlashingFlashingFlashingFlashingFlashingFlashingFlashingFlashing·FlashingFlashingFlashingFlashingFlashingFlashing	xx------------ Flashing FlashingXX Flashing FlashingFlashingFlashingFlashingFlashingFlashingFlashingFlashingFlashingFlashing	xxxxFlashingFlashingFlashingFlashingFlashingFlashingFlashingFlashingFlashingFlashingFlashing	High-speedLow-speedForcedidlingLow-speedLowspeedEnginestopForcedidlingLow-speedForcedIdlingLow-speed	EngineoverrunOillevellowCoolingwatertemp.highCoolingwatertemp.abnormallyhighBatteryvoltageabnormallylowBatteryvoltagelowBatteryvoltagehighBatteryvoltageabnormallyhighFaultyTPS('2)1dleposionFaulty TPSFaultyTPSFaultyTPSpowersupplyFaultyTPSpowersupplyFaultyairinjectorFaultyfuelinjector FaultyspeakplugFaultyignitioncoilFaultyFFP('3)FaultyCPS('4)Faultyenginetemperaturesensor	Approx.6,000rpmApprox.350miorlessApprox.9VorlessApprox..1OVorlessApprox.18VormoreApprox.20VormoreTPS1&TPS2TPS1&TPS2TPS1&TPS2TPS1&TPS2	Readjustpropellerandoutboardenginemountingheightandtrim.Replenish engine oil.Refertotroubleshootingtable.RefertoFaultIndicationTableusedforselfdiagnosingfunction.1:ESGspeedcontrolHigh-speed: regulatedtoapprox. 6,000rpm.Low-speed : regulatedtoapprox.3,000rpm.Forcedidling:regulatedtoiclingspeed.2: TPS ---: abbreviationfor1hroltlepositionsensor.3 FFP :abbreviation forfuel-feedpump.4. CPS :abbreviation for crank position sensor1

1. General Overview- Servicing the Raider Outboard

The most critical step in maintaining longevity of outboard motors is the break in period. Proper break in when first acquired and installed on the RIB is paramount to a long, successful militarized Raider outboard. Each Raider outboard is started and tested prior to delivery, however, the break in has not been completed. It is vital proper break in be completed on the new and rebuilt Raider. This section is important to successfully accomplish the break in for the Raider.

2.Test RunTank andTest Propeller



Engine speed at full throttle (rpm)
Approx. 5,000

- Test Run Tank Requirements and Precautions For Use

(1) Partition (required when testing two engines in one tank)

(2)Ventilation duct

(3)Water level

(4)Transom board

- The figure to the right shows the minimum dimensions required for the test run tank.
- The dimensions shown in the figure are the minimum that must be provided for a single engine,whether it be in a tank partitioned for two engines.

- Test Propeller

Out to diameter:198 mm

Out width:20 mm

Blade width:40 mm

Precautions for operation

- Continuous operation will raise the temperature of water in the tank,potentially causing the engine to seize up.,so it is important to maintain water temperature in the 25°C(7JOF) range. It is also recommended that cooling and over flow systems be installed.
- Over periods of continued use,the tank water gradually becomes contaminated by the waste discharged from the engine.This waste,which eventually coats the interior of the engine's cooling system,will reduce the engine's cooling capability,so it is important to change tank water on a regular basis.
- Over periods of continued use,engine exhaust fumes will accumulate near the engine. Engineperformanceisaffectedastheenginetakesinairwithincreasinglevels of these gases from the throttle body, so it is important to install mechanical ventilation system to maintain an exhaust gas-free environment around the engine.
- The water in the tank will tend to splash and spray out unless a sufficiently high of water is maintained in the tank.

3. Inspection

- **Items to Check Prior to Test Run**

- Fuel line condition
- Gear shift lever operation
- Electrical wiring,connections and clamps
- Operation,including catch,of reverse lock
- Integrity of self-diagnosing function
- Oil line condition

- **Items to Check During the Test Run**

Check the following items while the engine is in an idling state.

- Fuel leakage from the various joined seams of the engine.
- Water leakage from the various joined seams of the engine.
- Unusual sounds during operation.
- Idling speed and stability
- Stop switch operation
- Tachometer needle operation
- Clutch operation
- Engine speed during acceleration and deceleration
- Cooling water discharge(with sufficient force from water inspection hole)

- Additional Tightening After Test Run

- Retighten the various bolts to specified torque values.

- Breaking in Engine

- It is important to perform a breaking in of the engine in order to properly seat the sliding surfaces of the various parts in cases where pistons,piston rings,piston pins and cylinders have been replaced.
- Perform the various breaking in steps listed in the table below after pressure feeding engine oil and allowing the engine to idle for 10 minutes.
- Break-in period: approximately10 hours.

= **DO NOT** operate engine out of water. Water pump can be damaged or engine can overheat.

= **DO NOT** operate engine at a constant throttle setting. Change engine RPM often.

First 20 Minutes

- Operate engine in gear at fast idle **ONLY. DO NOT**exceed 1500 RPM.
- Verify water pump operation by looking for a steady stream of water at the water pump indicator.

Next 40 Minutes

- **DO NOT** operate engine above 1/2 throttle (no more than 3500 RPM).
- **DO NOT** hold a constant throttle setting. Change engine speed every 15 minutes.

Recommended: use full throttle to quickly accelerate RIB onto plane. Immediately reduce throttle to one-half as soon as RIB is on plane. BE SURE RIB remains on plane at this throttle setting.

Next Nine Hours

- Avoid continuous full throttle operation
- Verify water pump operation

Bring RIB onto plane and operate engine below 3/4 throttle. **DO NOT EXCEED** 4500 RPM.

Every 30 minutes, operate engine at full throttle for approximately one minute.

- **DO NOT** exceed recommended maximum engine RPM.

= Retorque cylinder head screws after engine break-in period. Retorque after engine has been run and cylinder heads have cooled to the touch.

Time	0 to10 min ➡	10 min.to 1 hr. ➡	1hr. to 2 hrs.➡	2hrs. to 10hrs. ➡	10 hours or more
Breaking in engine	At minimum speed At closed throttle	At half throttle	Full throttle for 1 minute,at 10 minute intervals At ¾ throttle or less	At full throttle for short intervals At ¾ throttle	At normal operating speed
Operating range		Approx.3,000 rpm or less	Approx.4,000rpmo rless	Approx. 4,000rpm	5,150to5,850rpm

Caution

- The use of inferior or non-standard fuels and oils cannot only shorten engine life but canal so cause starting problems and lead to breakdowns. Be sure to always use the designated fuel and engine oil types.
- Do not use a gasoline/oil mixture in this engine.

Fuel/Oil Requirements

Recommended Oil

Above 30° F: Biodegradable Outboard Oil
Below 30° F: 100% Fully Synthetic 2-Cycle Engine Oil

Recommended Fuel

Preferred fuels: Jet A, JP5 or JP8 jet fuel, Diesel DFM-E76, BioDiesel
Alternate fuel: gasoline, gasohol/ethanol

Storage of the Raider Outboard

Use the following procedure to properly prepare the engine for extended periods of nonuse. These steps are intended to protect the engine during storage and simplify the out of storage servicing procedure.

Note: Use a flushing attachment to prevent engine or water pump damage if you operate the engine on a trailer or dolly.

Safety:**When using a flushing attachment, always remove engine's propeller before starting engine to prevent accidental contact with moving propeller.**

2. Stop engine and remove all spark plugs. Spray a liberal amount of Storage Fogging Oil into the spark plug holes.

3. Pull starter to distribute the fogging oil throughout the cylinders. Install and torque the spark plugs.

! **Leave spark plug leads disconnected to prevent accidental starting during storage.**

! 3. Examine all hardware you loosened or removed. Replace damaged or missing parts with genuine RaCE parts or equivalent. These fasteners are made of special materials to resist weakening and rusting. **Do not substitute these fasteners with nuts and bolts, which look the same. Using the wrong nuts and bolts may result in sudden, unexpected loss of engine control.**

! 4. **Inspect the engine's steering, throttle, and shift systems for damage due to corrosion, aging, lack of maintenance, or abuse. Follow the maintenance and lubrication recommendations when servicing these systems.**

5 Replace the engine's fuel filter.
6 Clean and inspect oil reservoir. Fill the oil tank with recommended oil to reduce or prevent condensation from forming in the tank during storage.
7 Remove propeller and check for damage. A slightly bent propeller blade can hardly be noticed but will affect the performance of the engine. Clean the propeller shaft and lubricate with grease.
8 Drain and refill the gear case. Lubricate the engine. See **Gear case Lubrication** in this section.
9 Check the engine carefully. Make sure screws and nuts are tight. Replace damaged or worn parts.
10 Make sure electrical and fuel system fasteners and clamps are tight and in good condition**. Failure to do so may cause electrical sparks and fuel leakage under the engine cover. Fire and explosion could occur**.
11 Replace engine cover. Use touch-up paint where needed.
12 Coat all outside painted surfaces of engine with automotive wax.
13 The engine should be stored in a normal (vertical) position on an adequate engine stand.

Tune-Up Procedure for Raider Outboard
The following is described in the outboard does not meet specifications. It is a first step to decide if a tune-up is all that is required verses a major overhaul of the Raider.

1. Visually inspect engine for leaks, missing or loose parts, or other obvious defects.

2. **Compression check** - Proper compression is essential for good engine performance. An engine with uneven compression cannot be properly tuned.

- Operate the engine until it reaches its normal operating temperature. Stop engine.
- Remove and inspect all spark plugs. Check their condition.
- Install thread-type compression tester in spark plug hole.
- With throttle in wide-open position, pull engine through at least four compression strokes.

  Variation between cylinders should not exceed 15 PSI (103 kPa).

Results:

IF the engine has equal compression, is hard to start, **and** operates poorly, check for:

- scored cylinder walls
- damaged pistons
- stuck piston rings
- worn piston rings

IF the engine shows a variation greater than 15 PSI (103 kPa), check for :

- damaged head gasket
- damaged pistons
- broken or stuck piston rings
- scored cylinder walls.

IF the engine has equal compression and runs normally, continue the tune-up procedure.

3. Clean and regap or replace spark plugs. **Make certain ceramic portion of plug is not cracked. Replace if cracked to prevent sparks.**

4. Inspect ignition components. **Replace deteriorated or damaged parts such as wires, boots, etc., which may emit sparks.**

5. **Replace deteriorated or damaged fuel system parts such as hoses or gaskets which may result in fuel leaks.**

6. Check the throttle linkage.

7. Inspect propeller shaft seals for evidence of leakage. Replace if necessary.

8. Drain and refill gear case. Lubricate all components of engine. See **Gear caseLubrication**.

9. Check propeller condition. Replace if damaged.

10. Retorque all screws and nuts to specifications.

11. Run engine in test tank with correct test propeller. Check cooling system operation.

Anodes - Testing and Replacement
Anodes protect the outboard from galvanic corrosion.

Erosion or disintegration in sea or brackish water indicates the anodes are performing their function. The anodes should be inspected at intervals and replaced when necessary or corrosion of the engine will increase. If any anode has been reduced to 2/3 its original size (1/3 eroded) it must be replaced*

To test for proper installation of the anode. Set an ohmmeter to low ohms scale. Connect one lead of the ohmmeter to a powerhead ground and the other lead to the anode. Be sure surface of the anode is clean to make good contact. Ohmmeter should indicate a very low reading (zero). If not, remove the anode and clean the area where the anode is installed. The mounting screws and the anode itself should also be cleaned. Install and retest. Never paint or coat the anodes or their mounting surfaces, as this will prevent them from functioning properly.

When taking Raider Out of Storage and back into Service _____

1. Check gear case lubrication. If leakage is evident, gear case seals may need attention. See **Gear case Lubrication** in this section.

2. Apply a light coating of Electrical Grease to the ribbed portion of the spark plug ceramics and the opening of the spark plug covers. Connect spark plug leads. **Make sure spark plug boots are not cracked or torn**.

3. When engine is reattached to the boat's transom**, make sure the mounting brackets, clamps, and hardware are structurally sound and in proper working condition.** If mounting components use the wrong fasteners, are carelessly installed, or are defective, sudden unexpected loss of engine and boat control may result.

4. Check for evidence of water in the oil tank. Do not operate the engine if water is present in the oil tank. Serious powerhead damage can occur.

5. If the fuel hose has been disconnected, reinstall it.

6. **Check fuel system for leaks**.


RAIDER